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Sinking Poor Decision-Making with Best Practices: A Case Study of Artificial Reef Decision-Making in the Florida Keys

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SINKING POOR DECISION MAKING WITH BEST PRACTICES

A Case Study of Artificial Reef Decision-Making in the Florida Keys

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Public Policy and Administration at Virginia Commonwealth University.

by

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Abstract

SINKING POOR DECISION-MAKING WITH BEST PRACTICES: A CASE STUDY OF ARTIFICIAL REEF DECISION-MAKING IN THE FLORIDA KEYS

By Thomas Wayne Williams, Ph.D.

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The natural reefs of the world are experiencing higher use and pressures, resulting in anthropogenic impacts that are deteriorating many coral stands and creating poor water quality. The Florida Keys rely primarily on the reef system that surrounds the archipelago for their socioeconomic health and successful future. The Florida Keys shares the symbiotic relationship of the terrestrial and marine realms with many other states and countries and the experience of higher demand on the resource. Artificial reefs could provide a substitute to the natural reefs for commercial and recreational users. An increased demand for derelict vessels of the U.S. Navy and Maritime Administration has illustrated the popularity of their use as artificial reefs.

Local decision-makers do not have the experience to apply to an artificial reef proposal and many rely on existing anecdotal data and "expert" testimony. A lack of evaluation criteria adds to the difficulties of determining if an artificial reef proposal is appropriate for their community. With little empirical data available in the literature and

a lack of comprehensive pre and post deployment data completed, how does the decision-maker decide?

This study seeks to determine if a method exists that provides criteria and best practices for evaluation of artificial reef projects. Although the study's focus is on artificial reefs, this matrix could be modified to apply to any project where similar dynamics apply. The matrix uses a disaggregate method modeled after the Goeller scorecard. The model provides a best practice's matrix developed through a meta-analysis of three existing artificial reef projects, a comprehensive literature review, and interviews with three decision-makers at different levels of participation. The matrix applies identified best practices and provides a scoring method that can assist the decision-making process.

This study acknowledges the limitations of a research project such as this and realizes that many decisions in a political realm have variables not covered in a study of this scope. However, an identified lack of decision-making continuity demonstrates the need for such a study and the research provided within this study is an important first step.

Chapter 1
INTRODUCTION

Ancient peoples used their observations of the attraction of fish to foreign objects as a method of harvesting food. Relating the appearance of fish at sites where logs and rocks were located in the aquatic environment made the capture of the different food sources available. The Greek geographer Strabo recorded that the ancient Persian kingdoms built reefs across the mouth of the Tigris River to obstruct the passage of marauding naval pirates from India; blockading harbors with artificial reefs was a common naval strategy. About 200 years before Strabo, the Roman historian Polybius recorded that the Romans built a reef across the mouth of the Carthaginian harbor of Lilybaeum in Sicily during the First Punic War to trap the powerful enemy ships within and assist in driving the Carthaginians from the island (Hess et al., 2001). In more modern times, placement of structure underwater as habitat is done for several additional reasons such as commercial and recreational fishing, SCUBA diving, aquaculture, environmental restoration, natural resource management, and scientific research (Seaman, 2000). However, evaluation of the structures is not as simple as determining whether or not fish were present. Impact assessments, cost-benefit analysis, and myriad other considerations now must be accounted for – but by whom? The first documented artificial reef in the United States dates from 1830, when log huts were sunk off the coast of South Carolina to improve fishing. It was not until the latter part of the 20th century that artificial reefs took a community approach and most artificial reefs were built by *ad hoc* volunteer groups, albeit for the same reasons. Like the 1830 reef, 80 percent of the

reefs constructed off U.S. coasts have used materials of opportunity because they were free to the volunteers, or nearly so (Gulf States Marine Fisheries Commission, 1997).

Only in recent time, since the mid 1970's, have engineered structures been used for artificial reefs. Lately there has been an increased interest in using artificial reefs to replenish or replace depleted fishing grounds and to serve the relatively new activity of SCUBA diving (*Ibid*). According to a survey in the summer of 2000, authorities reported that over 846 vessels have been used for reefs during the past 25 years, and that there is near-term demand for hundreds more (Bell & Maher, 2000).

In 1994, the Atlantic States Marine Fisheries Commission (ASMFC) reported that at least 666 steel-hulled vessels had been sunk for reefs since 1974. Forty-one of these ships were donated to the states by U.S. Maritime Administration (MARAD) pursuant to Public Law 92-402, 1974 known as The Liberty Ship Act, amended in 1984 by PL 98-623 to include ships other than Liberty ships. Although the MARAD ships only account for 6 percent of the total, they constituted almost all of the 44 large ships sunk (over 300 feet long) (Atlantic States Marine Fisheries Commission, 1994). Nearly half of the 666 ships were very small fishing boats or tugboats no more than 75 feet long. There is a current demand among Atlantic and Gulf Coast states for over 540 ships just to meet the increasing need for improved fish resources (Bell & Maher, 2000).

History and Function of Artificial Reefs

Artificial reefs are created in many ways and from many materials, with uses that are limited only by the imagination. The following discussion presents a background of artificial reef creation and the diversity of use.

What is an Artificial Reef?

Artificial Reefs have been around as long as our ancestors have been tossing their objects into the water. Tree's, ship ballast, tires, cable-cars, and shipwrecks are all artificial reefs when using a broad definition. Items used in reef construction add vertical profile to the benthic environment, assembled as a reef or aggregated after being used for another, usually unrelated purpose such as a mothballed naval vessel. An artificial reef can be defined as one or more objects of natural or human origin deployed purposefully on the seafloor to influence physical, biological, or socioeconomic processes related to living marine resources (Seaman, 2000). However, such an extensive definition would require a discussion beyond the scope of this dissertation to adequately define the myriad types of artificial reefs; this discourse will focus on the use of ships as artificial reefs.

Ships as Artificial Reefs

Ships have been wrecking on reefs from the time ancient sailors took to the seas. When done unintentionally it is called a shipwreck, when done deliberately with thorough planning it is called an artificial reef. Artificial reefs provide new and important alternatives to otherwise obsolete structures such as mothballed ships and discarded materials such as porcelain toilets and concrete. However, for the purpose of this dissertation the term artificial reefs will refer to obsolete vessels primarily from the

U.S. MARAD and U.S. Navy's mothball fleets. Through an established artificial reefing program within these organizations, the ships are intentionally placed on the bottom of the ocean in a designated location after completing a comprehensive preparation process to ensure environmental compliance and safety concerns (i.e. penetration and cutting hazards). The purpose for deploying these vessels on the sea floor can vary significantly and is the subject of the following discussion.

Historical Use of Artificial Reefs

Artificial reefs have historically been used for enhancement of commercial fishing in two ways. First, almost immediately after the artificial reef deployment the attraction of mobile organisms to the structure is anticipated by interests seeking to increase catch or the structures' efficiency of attracting and providing habitat of target species of fish. Secondly, there is an expectation that ecologically the artificial reef will resemble the local natural reef over the long-term as assemblages including sessile organisms associate with its surface, structure, and surrounding water column and eventually increase biomass at the site as illustrated in Figure 1. This aspect has led to redefining the historical use of an artificial reef in the last decade from simply fish attractors to include ecosystem developers as this use may be essential for some purposes of artificial reefs such as providing non-consumptive recreation for SCUBA divers and visitors to the site for observation. As the popularity of artificial reefs increase and their uses diversify, it is important to include socioeconomic and resource allocation functions, as well as non-market use in their use definitions to accurately represent what they are, how they can be used, and their positive impacts.

Figure 1 ***USS Benwood*****. Retrieved on 2/23/05 at http://oceandivers.com/photos/wrecks.**

Figure 2 ***USS Benwood*****. Retrieved on 2/23/05 at http://oceandivers.com/photos/wrecks.**

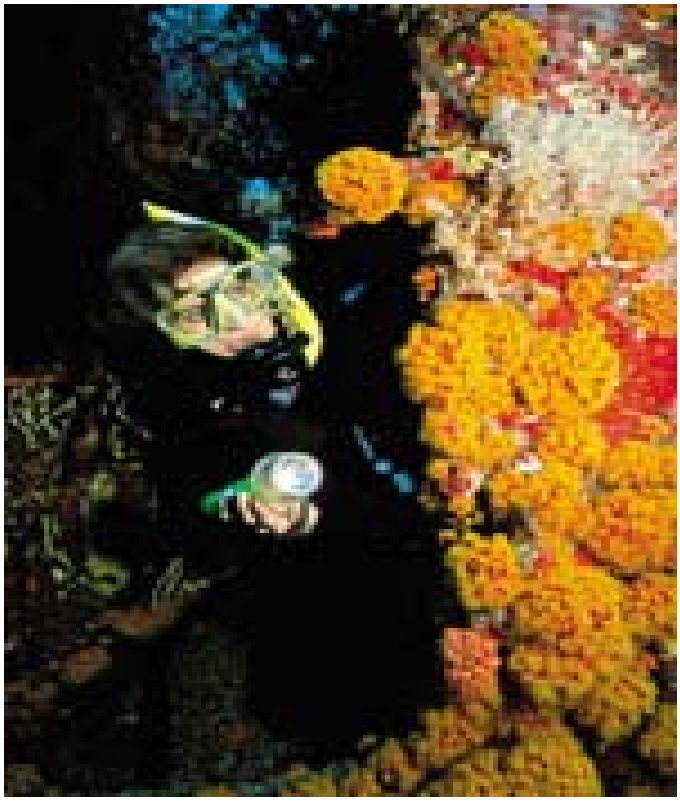

Figure 3 ***USCGC Duane*****. Retrieved on 7/21.06 at http://www.scubadiving.com**

Artificial reefs that are physically stable offer sites for A, growth of plants; B, shelter and habitat for fish; and C, gathering of pelagic species.

Uses of an Artificial Reef

Shortly after a ship is wrecked, the structure begins to be covered by corals, seafans, sponges, and other invertebrates. Microorganisms, plankton, feeder fish, and other members of the food web congregate, supplying the necessary elements to sustain the ecosystem. Soon pelagic species such as sharks and tuna are frequent visitors, providing target species for commercial and recreational users such as fisherman and scuba divers. Even before the structure becomes transformed, there are many uses of artificial reefs as illustrated in Table 1.

Table 1 Uses of an Artificial Reef
Increase Recreational/Commercial Fishing Production
Recreational Skin/SCUBA Diving Sites
Habitat Protection
Conservation of Biodiversity
Research

Increased interest in artificial marine habitats comes from a variety of commercial, recreational, conservation, and management sectors. Their goals can be quite different and include exploitation of fish stocks for food, restoration of benthic habitats, and conservation of biodiversity (Hess et al., 2001). Regardless of the goal, artificial reefs can produce benefits for the community from the economic streams that begin to flow from the beginning of the marketing campaign through the maturation process of the artificial reef as it becomes its own ecosystem.

The "Artificial" Reef

Labeling these reefs as "artificial" should be considered erroneous. Granted, at initial introduction into the marine environment these structures are appropriately described as they lack the characteristics associated with a reef's ecosystem. However, after a short time the surfaces of the "artificial" reef become encrusted with organisms and soon the "artificial" reef is functioning parallel to the surrounding natural reefs. As shown in the photographs in Figure 1 above, marine life does not discriminate between the newly created ecosystem and the natural reef ecosystem – they are in fact part of the same underwater environment and consequently perform the same functions. So what is "artificial" about these anthropogenic reefs?

As discussed above, artificial reefs can have a positive impact to the environment. The following discussion addresses the artificial reef transformation to a functioning

ecosystem. The discourse will include function, development, biological evaluation, maturation, and include some background of the controversy surrounding artificial reefs.

The Artificial Reef Ecosystem

Understanding the function of the artificial reef ecosystem is helpful in paralleling the "artificial" with the natural reef ecosystem. An overview of the artificial reef must include the marine life that inhabits and visits artificial reefs with a discussion of the basic elements such as nutrients, plankton, and resident species. The marine flora and fauna quickly inhabit the structure and begin to serve as habitat for bait fish and other species. The explosion of life that occurs during the establishment of the artificial reef ecosystem quickly includes the grazers and predators such as parrotfish and groupers transforming the site into a desirable destination for market uses such as fishing and snorkeling/SCUBA diving. Other important aspects of the evolution of an artificial reef include the physical dynamics such as current, light, and salinity; however, these elements will not be discussed here as the technical aspects in the engineering of an artificial reef project are not part of the evaluation of decision-makers that are the subject of this study.

Function

Nutrient and primary productivity regimes rarely have been incorporated into artificial reef monitoring programs because they often require more technical training and expensive equipment than generally available to most reef builders; however, these factors are important aspects of ecosystem function and should be considered in the future (Valiela, 1995). It is especially important to collect nutrient and primary

productivity data during the site selection phase of a project to ensure a site's suitability for the satisfying the criteria of a given artificial reef project. According to Parsons et al. (1984), two of the major categories of artificial reef objectives are enhancement of fisheries production and mitigation (i.e. creating habitat to compensate for anthropogenic loss or damage to natural ecosystems). Using the definitions provided by Valiela (1995), nutrients, in this context, refer to forms of the elements nitrogen, phosphorus, and silica, which plants need to exist. These nutrients are combined with carbon (from carbon dioxide) and produce food for sea-life. Primary production is the process of organic matter produced from this process via photosynthesis/chemo synthesis (without light) as illustrated by Seaman (2000) in Figure 4.

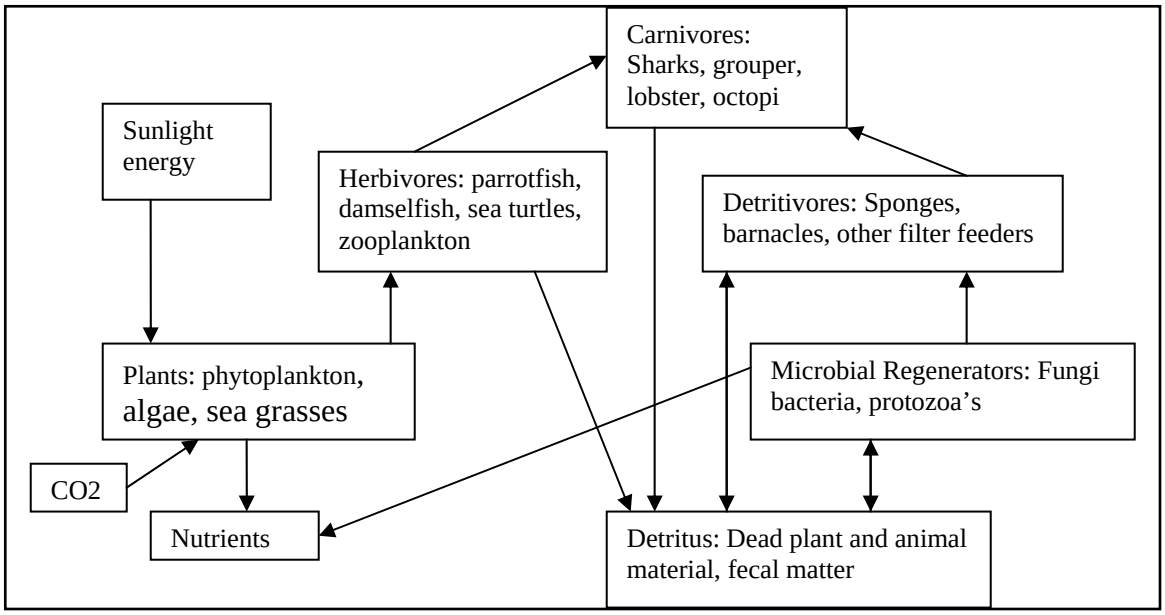

Figure 4 Generalized Marine Food Web (Seaman, 2000)

Artificial Reef Ecosystem Development

Once the basic trophic requirements have been established, the artificial reef site begins to develop its own ecosystem as illustrated in Figure 5 below. Filter feeders,

invertebrates, crustations, feeder fish, grazers, and predators begin to appear. Pelagic species such as sharks, rays and skates, jacks, etc. visit the site and provide opportunities to increase the diversity of the site. As corals, fans and other vegetation become established on the structure, the reef begins to provide shelter for juvenile and larger fish. Target species such as grouper, lobster, etc. begin to aggregate or can be planted to provide for the determined objective (e.g. sport diving/fishing, research, etc.). The site should quickly begin to relieve pressure and prevent anthropogenic damage on other sites and natural reefs (Seaman, 2000).

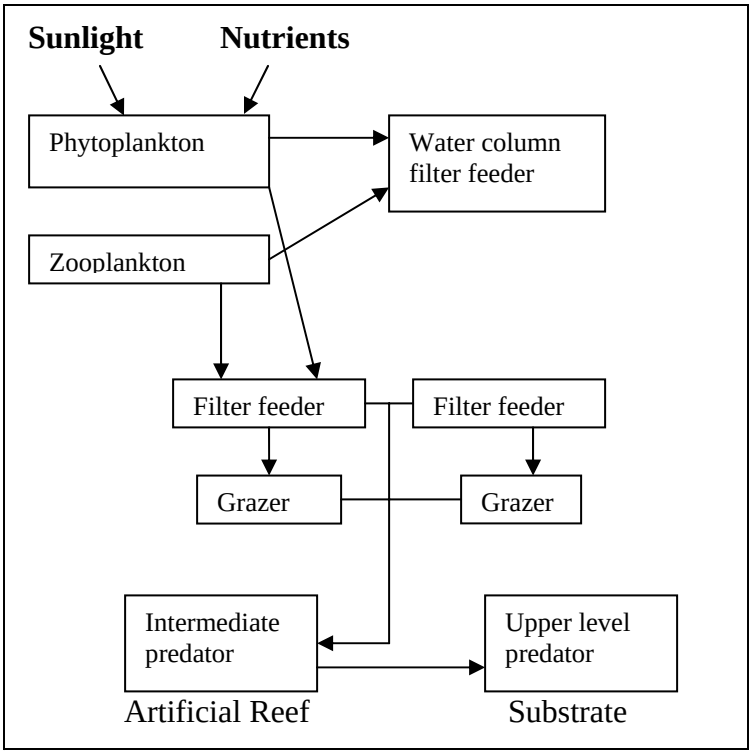

Figure 5 Food-chain organization (Seaman, 2000)

Evidence of the success of an artificial reef ecosystem can be measured several ways, but the most effective may be by fish counts. The Reef Environmental Education Foundation (REEF) has performed fish counts on many reef sites in the Florida Keys.

Their data are available on their website and demonstrate the diversity of the species that are on or near artificial reefs.[1]

As cited by William Seaman (2000), there have been many studies, reports, and articles providing testimonials to the success of artificial reefs in commercial fishing. However, the most illustrative may be the success of Alabama's artificial reef program. Auburn University Fisheries Professor Stephen Szedlmayer recently conducted a study of the diets of red snapper and gray triggerfish taken from artificial reefs and concluded that artificial reefs are productive environments for both species based on the ability for reproduction. The research concluded that the artificial reefs were increasing the biomass of the fisheries (Bailey, 2001).

The process in which the artificial reef develops is called "maturation". This process is discussed below and provides the next stop on the artificial reef continuum.

Artificial Reef Maturation

To accomplish the objectives of an artificial reef project, the site is usually evaluated after there has been enough time to create and sustain an ecosystem. Maturation occurs when the site has established the nutrient and productivity discussed above, and in addition has established colonies of "reef fish" and flora associated with natural reefs. Corals, fans, sponges, invertebrates, and colonizing fish such as grunts or blue tangs indicate that the site has established the basal requirements for sustaining the ecosystem. The presence of "resident" species at the site attracts larger predators such as

[1] See REEF's website at www.REEF.org and navigate to the data link and specify the desired site

barracuda, grouper, and sharks. Predators complete the food-chain and are usually the target species desired by site users (i.e. divers and fisherman).

Maturation Evaluation

Bortone et al. (1994) evaluated features of reefs in the northern Gulf of Mexico to determine associated fish fauna species number, abundance, size, and biomass. The study design was organized around the deterministic hypothesis that some set of conditions (both environmental and reef attribute) may interact to affect the associated fish community rate of maturation. Martin and Bortone (1997) conducted a similar analysis to evaluate macro invertebrate community attributes using the same variables with similar conclusions. In sum, these studies indicate that the rate of maturation depends on not only anthropogenic contributions, but also environmental and consequently each site can have different maturation rates. This is important when planning an evaluation to determine a project's success, and when a site is to be accessed by users.

Maturation of an artificial reef is somewhat subjective depending on specific objectives. Environmentally, a site needs to provide for basic food requirements and compatible species to develop the food chain. Dominance of a specific species could be damaging if it prevented the development of other species integral to the development of the ecosystem. Maturation rates vary, as to the purpose of the sites. Whatever the purpose, it is important to incorporate proper evaluation protocols to ensure data can be collected and evaluated to help develop other sites and objectives. The maturation point of an artificial reef project is difficult to identify, but through continuous observation and

evaluation standards and characteristics will be established and increase the understanding of the dynamics of artificial reefs (Martin and Bortone, 1997).

The Artificial Reef Controversy

Many articles appear denouncing and/or opposing an artificial reef project as soon as significant interest is shown. However, most involve an agenda that is not of public interest but of private gain or loss; there are a few exceptions that merit discussion. One controversy caused by the use of derelict vessels proposes that these potential reefs pollute; the argument that the artificial reefs constructed from mothballed vessels leak oil and contain hazardous substances such as asbestos. An artificial reef program or the adoption of best practices would require that preparation for deployment would include a comprehensive cleaning with established measurement to ensure no contaminants are released. To receive a permit from the various agencies, certification that the vessel is "clean" is one of the many steps in the permitting process. Concerns of contamination are justified; however, rarely are they realized. For example, the Artificial Reef Society of British Columbia reported sinking decommissioned warships to increase biodiversity and support diving tourism. The environmental concerns came from the Georgia Strait Alliance, along with other environmental groups who stated that the ships contain oil and other contaminants in inaccessible areas such as crank cases, fuel tanks, and day tanks. The groups stated the ships also contained hazardous materials such as asbestos and paint with tributerol tin (TBT). Environment Canada (equivalent to the U.S. EPA) found in a study conducted two years after the sinking the vessel that there were no elevations in the concentrations of any water quality parameters measured (Eggan, 1997). This example is

repeated several times in the literature with the same results (*Ibid*). The accepted practices for preparing a vessel for use as an artificial reef are considered safe, and are monitored by the government agencies charged with environmental oversight.

Another issue of concern is that artificial reefs are a guise for ocean dumping. The argument is that the variety of materials being used in artificial reefs such as tires, concrete blocks, and other materials heavily regulated by ocean dumping agreements and statutes, are not being properly prepared for use as an artificial reef – only dumped. There need to be strict criteria for creating an artificial reef that includes cleaning and preparation of the material. Many of the issues discussed here address materials not the focus of this study but are important to acknowledge for a complete understanding of the reference point people bring to decision-makers when such a project becomes noteworthy in a community. For this dissertation the definition of "artificial reef" is referring to large vessels such as the U.S. Navy and Maritime Administration's mothballed fleet, not to small scale materials such as refuse items (i.e. toilet bowls or scrap building materials).

The United States and the international community have promulgated regulatory measures designed to prevent the abuse of artificial reef placement. The regulations are intended to ensure that fishery habitat enhancement will not be used as a pretext for disguised ocean dumping. The international agreements and accepted principles of international law, however, provide only discretionary protection. Guidance over artificial reefs in U.S. waters consists of international standards and domestic statutes in conjunction with agency actions often thought of as inconsistent, thereby creating an increased opportunity for disguised ocean dumping (Macdonald, 1994).

However, artificial reefs have empirical and anecdotal documentation for their benefits that are critical to the biological and socioeconomic health of a community such as the Florida Keys.

The Benefits of an Artificial Reef

A discourse on artificial reefs would not be complete without acknowledging the benefits to the environment that artificial reefs are having. In the Australian Institute of Marine Science's Status of Coral Reefs of the World (1998), the report describes deteriorating water quality in the waters of the Florida Keys. The deteriorating water quality can be best exemplified by the recent NOAA Coral Reef Taskforce meeting held on May 4, 2006, where NOAA placed two coral species on the Endangered Species List: Acropora palmate (elkhorn coral) and A. cervicornis (staghorn coral) effective May 9, 2006 (NOAA, 2006). However, the report does note that the use of artificial reefs have contributed to the improvement in conditions. Much of the literature specific to the Florida Keys addresses the tendency to "love to death" the reefs. This study suggests that the use of artificial reefs has significantly lessened the pressures associated with tourism of the natural reefs. Here again, the issue of carrying capacity of the reef system is addressed as a positive relationship between the lessening of pressure on existing reefs and the establishment of artificial reefs. In addition, the increased numbers of corals and filter feeders has improved water quality and possibly increased juvenile fish of commercial and sport species such as the grouper and other valuable reef species such as lobster. Artificial reefs provide additional habitats for the development of these and other species that feed the food chain (Central News Agency Taiwan, 2000) (Discover, 1991).

Conclusion

So, should we use mothball vessels as artificial reefs, or should we not deploy artificial reefs to begin with? How do decision-makers determine whether to approve a proposed artificial reef project? Chapter 1 has provided some background of the history and function of artificial reefs. The following Chapters will explore the decision-making process of three artificial reef projects and examine the decision-making process in Florida Keys.

Artificial reefs have a diversity of uses that date back to ancient times. Today, artificial reefs can play an important role in conservation and restoration of natural reefs by relieving use pressures and establishing habitats to increase the marine life within these mini ecosystems. The biological elements necessary to establish and sustain marine ecosystems are present in artificial reefs and with proper planning and use strategies they can be successful in realizing their intended use while minimizing unintended consequences.

Chapter 2
PROBLEMS AND METHOD

With the overview of artificial reefs completed, the discussion now introduces the problems decision-makers face in evaluating a request for a new artificial reef project. Chapter 1 discussed the historical use of artificial reefs; however, that retrospective approach does not provide decision-makers with the process to evaluate the impacts and innovative objectives that are being proposed today. Previous economic and ecological studies have provided the baseline data as to the potential of artificial reefs. However, the need to evaluate proposals with consistency requires identification of critical evaluation elements – also known as best practices.

In this study, I consider the decision-making process for artificial reefs in the Florida Keys. While the impact of artificial reefs in the Florida Keys has been studied from both the ecological (FKNMSMP, 2005, Maher, 2004, NOAA, 2003) and economic (Bell et. al, 1998, Hazen & Sawyer, 2001 and 2003, Maher, 2004, NOAA, 2003) perspectives, no comprehensive approach to decision-making is presently available. The research in this study has identified that the use of best practices is absent from current decision-making practices; this study seeks to fill this gap by developing a best practices model to be used in the development of a decision-making matrix.

The dilemma facing decision-makers when evaluating a proposed artificial reef, or any development policy problem, is how to determine whether or not the project will be beneficial to the community and the environment. To address the dilemma, it is important to ask two questions: What is the existing decision-making process? Is the

existing process effective? Once these questions are answered, the existing decision-making process can be improved, but by what method?

This Chapter discusses the decision-making problems facing the decision process in the Florida Keys. Following the discussion on the decision-making problem, the Problem Statement and Hypothesis are established. The discussion then explores the method used in this study to evaluate the existing decision-making process. These methods are culminated in the development of best practices.

Decision-making Problem

There are many issues facing decision-makers in evaluating an artificial reef project. The most significant device absent from the process may be the lack of decision-making documentation in the literature and applicable development projects to use as examples. To compensate for the lack of examples, establishment of best practices could bridge the gap between the lack of experience and/or empirical data and standardized decision-making processes as discussed in interviews with key agency personnel who identified the lack of decision-making protocol as the most significant obstacle to effective decisions.

There are many elements required in order to begin assembling a protocol for decision-making. This study discusses the decision process through the different agencies of the Florida Keys and introduces a best practices model for use in a decision-making matrix. The best practices model will establish what criteria are most helpful to decision-makers when evaluating the material in a proposal. The lack of experience and/or credible documentation requires the decision-maker to identify the type of

information that would be most helpful in the decision process. However, before diving into the solution alternatives, an understanding the decision-making and policy development problems facing decision-makers are necessary.

The decision-making process is complicated by the multiple agencies that are entwined in the regulating of the Florida Keys. Designated as A State Area of Critical Concern, the Florida Keys are subject to review by the State of Florida Department of Community Affairs (DCA). The coastal water's that embrace the archipelago that is the Florida Keys is governed by the Florida Keys National Marine Sanctuary (FKNMS) which includes representation by the U.S. Army Corps of Engineers (ACOE) and the Florida Department of Environmental Protection (FDEP), and the National Aeronautical and Atmospheric Administration (NOAA). Juxtaposition with the environmental groups, developers, community pressures, and special interests, decision-makers in the Florida Keys have a plethora of perspectives to consider.

The continuum of decision-making problems seems perpetual as each problem tends to build upon the previous. Without an established protocol a request for deployment of an artificial reef cannot follow a standard that decision-makers can apply. So how are decisions being made? The problem within the context of artificial reef decision-making extends from a lack of a fundamental understanding of what artificial reefs are, what they can do, and how they should be deployed. Consequently, decision-makers rely on public testimony, staff reports, and input from the developer and the public through the permitting process and public hearings. This testimony is often unreliable and scripted by special interests. For example, at a public hearing held for the

proposed artificial reef project *Vandenberg* in Key West on May 3, 2000, organizers against the project bused people from Florida City approximately 130 miles east of Key West to give the illusion of strong support against the project, until the project's organizer challenged some of the speakers and asked that their residence be acknowledged, resulting in subsequent citizen's request for comment without local drivers licenses or recognized by a Commissioner to be denied.

In the course of this study these questions are researched and analyzed to determine what, if any, alternative decision-making processes can be developed. This Chapter will identify the existing artificial reef decision-making method practiced in the Florida Keys. The discussion will provide the Problem Statement and Hypothesis for this dissertation and address the dilemma facing decision-makers in the Florida Keys. This Chapter will discuss the concept of best practices used in decision-making and the method by which this dissertation developed the proposed decision-making matrix that implements the principles of best practices identified by notable Florida Keys decision-makers.

Problem Statement & Hypothesis

The Problem Statement for this dissertation is: **"Does the process used by local government decision-makers in the Florida Keys when considering an artificial reef project utilize best practices?"** The Hypothesis is **"Local governments in the Florida Keys do not utilize best practices when considering an artificial reef project."**

The Hypothesis will be tested by analyzing the decision-making process for artificial reefs in the Florida Keys through a meta-analysis of existing artificial reef

projects, literature review, existing decision-making processes of Monroe County and structured interviews with central decision-makers at different levels of the decision process. In addition, an analysis of the existing decision-making process utilized for artificial reefs in the Florida Keys, specifically the *USS Spiegel Grove* and the *USS Vandenberg*; the most recent artificial reef projects in the Florida Keys. The result of this meta-analysis will test the hypothesis together with the literature review, case studies of existing artificial reef and growth management decision-making, and interviews with key decision-makers. This study focuses on the decision process and the problems facing decision-makers. The study creates a best practices model utilized in the development of a decision-making matrix, a tool that could be extended with minor modification to any comprehensive decision-making process.

Method

The method used in this research included a comprehensive literature review, interviews with key decision-makers utilizing a standardized questionnaire, and the review of three recent artificial reefs projects. It was evident from this research that there was a need for a standardized protocol for decision-making. Recognizing the need for a decision process that included best practices was a central theme in the interviews as well as a need for a consistent method of evaluating proposals for development where examples and/or experience were lacking.

The following method discussion will address different assessments and evaluations found in the literature that corresponded to the decision-making process found in the interviews. The methods were not used by the interviewee's in their entirety

but fragments of these methods were found to exist in the decision process. The discussed methods in combination with existing literature were used in developing the best practices model and the decision-making matrix.

The discussion of method begins with those methods found in the literature to be most appropriate for developing the best practices model and decision-making matrix. Although these methods may exceed the level of understanding of most of the decision-makers, their principles were useful in the development of the study. For example, the first method discussed is Assessment Method which is a method focused on measurement. However, the principles identified help in setting criteria for *ad hoc* committee review such as those used by the Tourism Development Committee (TDC), Development Advisory Committee (DAC), or the Sanctuary Advisory Committee (SAC). At the conclusion of each method discussion, a brief summary will be provided to identify how the method could be used within the context of decision-making.

Assessment Method

According to Seaman (2000), there are three basic types of assessments: 1) Descriptive; 2) Processes; and 3) Integration.

Descriptive assessment asks questions to determine if this type of assessment is appropriate determined by the objective involved. These questions include what are the concentrations of nutrients at the reef site; what kinds and amounts of plants and filter feeders live on the reef; and how do these factors vary over space and time? Techniques used here would include collection of water or sediment samples, underwater light

meters, photographs, algal species checklists, and scrapings of reef surfaces to identify algae and invertebrate growth.

Process assessment is comparative oriented. Questions to determine if this method is correct would include what the sources and characteristics of nutrients are to and from the reef site; how are they incorporated into reef organisms; and what are the pathways of transformation and recycling within the reef system. Techniques here would include hydrographic data collection, nutrient analysis from water column and sediment, nutrient transformation rates, and incubation measurements for primary production.

Integration, the third type of assessment, would determine the factors that affect rates of primary production. The types of questions would address the production characteristics that the site or reef design might enhance. Techniques to help answers these questions would include incorporation of artificial reef studies from different areas, and experimental studies designed to test how different factors influence nutrients and productivity.

Of course, the level of assessment usually determines the depth of insight into reef function; the more detailed the assessment the more insight into reef function. For example, measurements of nutrient concentration provide a snapshot description and are less useful than comparison studies because a comparison of concentrations reflect the balance between supply and utilization. Type One studies will assess patterns in reef characteristics, and Type Two and Type Three studies are necessary to determine the processes that are causing these patterns. In sum, a Type One study might answer the

question “Is the reef meeting its objective?” but Type Two and Three studies are required to answer the question of why or why not.

Assessment method is identified in the post-deployment evaluation of the *Spiegel Grove* and discussed as a provision of the *Vandenberg’s* proposal. Assessment was also identified by the Florida Keys National Marine Sanctuary (FKNMS) Superintendent in the discussion with early artificial reefs, the *USCG Duane* and *Bibb* and as part of any evaluation process used in the FKMNS. However, the Sanctuary Advisory Committee (SAC) as an advisory committee could provide a written report that outlines these three assessment elements to standardize the information given to the decision-makers. The standardization of the data removes the perception of subjectivity and capriciousness in the evaluation.

One way to complete an assessment is the use of evaluation(s). Biological and socioeconomic evaluations can provide rich information and allow the decision-maker to understand the scope of impacts an artificial reef project may have. The following is a brief description of biological and socioeconomic evaluation methods. Although this overview is general in nature, it does provide a basal understanding of the two evaluation concepts.

Biological Evaluation

Perhaps the best method for determining the success of an artificial reef as an ecosystem is to evaluate the assemblage of fish and macro invertebrates inhabiting artificial reefs through a biological evaluation. To better understand this process there must be some discussion of the factors that may impact species composition and the

condition or fitness of the individuals. These factors can be classified in terms of abiotic and biotic variables.

Abiotic factors are variables that may be organized into two groups: 1) environmental factors, and 2) reef-attribute factors. The former having features related to the natural environment, and the latter having factors related to the artificial reef itself. These factors are important because the can determine what to control for and how, or what method to use, for the control. Environmental factors generally cannot be easily manipulated in the design, construction, or deployment process of an artificial reef. Conversely, reef-attribute factors can be manipulated during these phases to better produce the intended or desired outcome.

Environmental factors responsible for affecting fish and macro invertebrate assemblages and their association on artificial reefs are numerous. These factors have immediate impacts on the features of the reef and may severely limit the effectiveness of some assessment techniques. For example, local weather, water conditions, and temperature can influence assemblages (Bouchon-Navaro et al., 1997). Fish and macro invertebrates display varying degrees of mobility; some are found on the reef (i.e. coral), whereas others are located above or around the structure (i.e. barracuda).

Reef-associated factors are those variables that are controlled by the reef designer, builder, and to some extent, the deployment (Martin and Bortone, 1997). Some measures of reef –associated factors include dimension (i.e. size), texture, and architectural complexity (i.e. nooks and crannies for fish to hide in).

Biotic Factors are categorized into three main types: individual, population, and assemblage/community. For example, the amount of algal cover, coupled with a number of sea urchins, may be used as a variable to explain the presence, abundance, or condition of fish and macro invertebrates on the reef. Individual factors are considered life-history features such as life stage (i.e. larva, juvenile, or adult), size, growth rate, and condition to reproduce. Population factors include estimates that pertain to the overall status of a single species on a reef. For example, estimates of abundance, density, biomass, and population structure can help determine the overall health of an individual community on the artificial reef. Assemblage factors are species richness and abundance, and may include community diversity.

There are numerous methods to assess the health of an artificial reef ecosystem. Seaman (2000) categorizes assessment techniques into two methods: 1) Destructive Assessment, and 2) Non-destructive Assessment.

Destructive assessment has been historically used by commercial, recreational, and subsistence fisheries and includes trapping, hook-and-line fishing, trawling, netting, spearfishing, poisoning, and explosives (Cappo and Brown, 1996). Fishery independent methods use the same techniques but under more controlled conditions as to time, area, gear size, etc. Although fish can be released from hooks and traps, there is still stress and potential damage done to the fish using these methods.

Non-destructive assessment uses visual and non-visual methods. Visual methods include observation such as those performed in fish counts by REEF discussed earlier. Other methods include strip transects. This method uses two divers that transect along a

specified length and width within standardized protocol. Disadvantages to visual methods are environmental features such as poor light, visibility, bad weather, or strong current.

Socioeconomic Evaluation

Decision makers frequently judge the value or performance of a reef on its contribution to human satisfaction (Milon & Schmeid, 1991). For example, a reef that is not used by people is not a successful reef. The "success" could be measured by the number of scuba or fishing trips to the reef, the specific threshold number determined by the proposed objectives of the project. Socioeconomic data can be collected and evaluated to measure the dynamics of artificial reef usage and gauge the extent to which the "public benefit" is served. Socioeconomic data collection and evaluation are also an integral part of a strategy for resource use whereby monitoring and evaluating the public responses must be conducted to assess the initial working hypotheses, to reduce scientific uncertainty, to inform the public, and if necessary to develop alternative hypotheses (*Ibid*). Information on usage is helpful to justify previous or future public expenditures on artificial reef projects, therefore social and economic evaluation can be useful to decision-makers in demonstrating to their constituency a benefit from an artificial reef. These benefits can range from economic stimulus, social enhancement, and non-use benefits such as preservation and posterity.

The primary data source for existing socioeconomic assessment method for artificial reefs in the Florida Keys comes from the Hazen Sawyer Report published in 2001 with a supplement for the Florida Keys in 2003 which conducted the only

comprehensive study of the Florida Keys' reef system's socioeconomic impact and is discussed in Chapter 3 in more detail. The Florida Fish and Wildlife Commission, the NOAA, and the four counties of Southeast Florida (includes Monroe County also known as the Florida Keys) sponsored the study. The Hazen & Sawyer Report is used extensively for the data and analysis in the NOAA Study (2003), to provide the baseline evaluation data. The Hazen & Sawyer Report was published in October 2001 with the final report relative to Monroe County revised by NOAA on April 18, 2003 because of some problems with the original data collection method.

The socioeconomic evaluation method is present in the decision-making for both the *Spiegel Grove* and *Vandenberg* as the Hazen & Sawyer Report and NOAA Study were staples of discussion during the proposal process. Socioeconomic benefit is an underlying requirement during the evaluation process as identified in the interviews. Using measurement methods such as the Travel Cost Method (TCM) to determine user value may misrepresents the socioeconomic value of a project. As demonstrated in the *Vandenberg* analysis, willingness to pay in the form of a charter trip fee does not represent the full range of monetary value of the project. In addition, many non-market values were identified as demonstrated by institutional and scientific use interests.

Socioeconomic evaluation is a valuable tool but must be designed to identify the full user value of a project. The following method discusses user valuation methods that can be incorporated in the discovery criteria of the advisory committees such as the Tourist Development Council (TDC) and Development Advisory Committee (DAC). User valuation methods were also identified by the interviewee's as an important element

in the decision-making process, but not understanding the scope of this method limited their ability to make a comprehensive evaluation, thus diminishing the value of the decision.

User Valuation Methods

User valuation is an important element in the decision-making process because it gives a tangible method to identify impacts that can be defined monetarily as costs and benefits. The discussion here identifies the most commonly used valuation methods. Socioeconomics is the principal consideration by most decision-makers in the Florida Keys as the ecological and biological health of the Florida Keys' reefs is intricately connected to the socioeconomic health of the community.

The existing studies discussed here, as well as most socioeconomic studies that were reviewed, use valuation methods that are based primarily on the Willingness-To Pay (WTP) and the Travel Cost Method (TCM) models. There is also discussion of other similar methods with a plethora of sources such as Contingent Valuation (CV), Individual Transferable Quotas (ITQ) and other value assessing and transferring techniques. For the purpose of this research the following methods are most appropriate as they were the method used in previous studies: CV (Arrow et al., 1993)(Waldman, et al., 1996), WTP (Frykblom, 1997), TCM (Rosenthal, et al., 1984), and ITQ (De Alessi, 2004). Cost of Leisure Time models were also reviewed and applicable in part; however the principles were not determined to be as applicable as those mentioned above (Feather & Shaw, 1999). While these models can produce valuable data and provide some insight as to a

superficial understanding of perceived value, they fall far short of establishing accurate valuation of natural resources such as natural and artificial reefs.

The use of these methods are appropriate, in most cases, for the projects they were evaluating; however, user value extends beyond the monetary designation and must reflect other methods of value such as stewardship or other ethical consideration. Monetary value is however the most commonly used and therefore the focus of much of the research (Frykblom, 1997).

User Value method was identified at all levels of the decision-making process and is perceived to be connected to socioeconomic performance as indicated by the interviews. However, the lack of understanding by the decision makers exposes the decision to arguments and appeals that can delay or risk denial of a project. WTP and TCM may not be appropriate as the sole valuation method of a proposed project. As identified by the *Vandenberg*, non-market and non-use values are evident by the donations and sponsorships received by the organizers. In addition, the diversity of uses proposed for the project do not apply to WTP and TCM models in a traditional form, but could be considered in leases or contracts for the uses proposed. Regardless of model, User Valuation methods are important to decision-makers as identified in the interviews. Providing a standardized set of criteria for establishing what method is to be used, including a hybrid of multiple methods, should be developed for use by the advisory committees.

The fragmented nature of different methods identified in the literature and as applied in the decision-making process indicates a need for continuity and structure. In

order to achieve a process that provides a consistent and equitable method, a model of best practices as described by the literature and interviews must be created.

But what are best practices? The following discussion explores the concept of best practices and introduces a model derived from the previous discussion.

Best Practices

What are the best practices for deployment of artificial reefs? To answer this question, a review of the interviews and existing literature is necessary. To this body of information, lessons learned from previous artificial reef projects must be included. Once best practices are established, a decision-making matrix can be developed. To that end, the balance of this chapter will review the previously discussed information to establish best practices and develop a decision-making matrix.

For this study, best practices are those standards or principles that establish decision-making in the most comprehensive manner. Accepting the precautionary principle as the overarching premise, the best practices utilized in the decision-making matrix aspires to create a process to review an artificial reef project for the different perspectives discussed above, or otherwise identified as necessary by the decision-makers. From the interviews the common theme for best practices included more involvement by the TDC and DAC with consideration of market and non-market user values and expected socioeconomic impacts. In addition, a clear and succinct understanding of the goals and impacts of the artificial reef project needs to be identified prior to submission of a request such as a “no take” provision to protect target species such as lobster. Along with the SAC these three committees provide the decision-making

body with the analysis of documents and testimony provided during the permitting and approval processes. Getting to the decision-making body is a complicated process that can take a great deal of time and several attempts, with multiple public hearing requirements. Decision-makers do not want to have to perform discovery during their review; rather they want to have the comprehensive reports identify the elements considered critical to the decision-making process.

The best-practices model as illustrated in Figure 6 incorporates those principles most desired by the interviewee's and as discussed in the literature as cornerstone elements for decision-making.

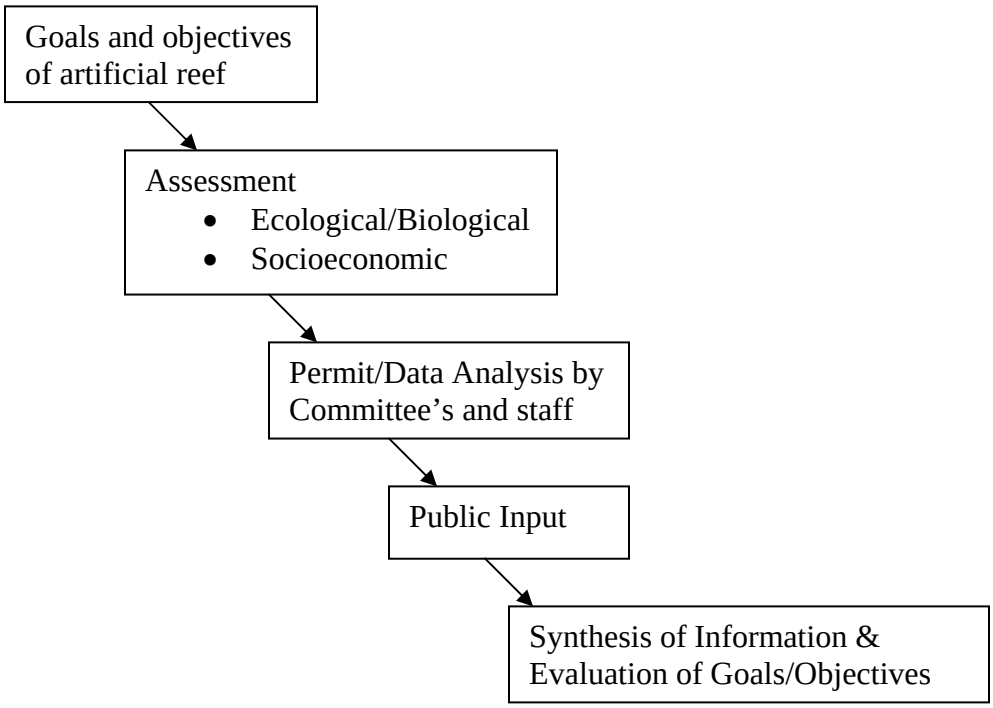

Figure 6 Best Practices Model

The method used in this research draws from existing literature and artificial reef projects and combines identified best practices from interviews with key decision-

makers. This method will produce a decision-making matrix that incorporates in more detail the best practices identified in Figure 4 and provide decision-makers a tool to evaluate the decision process surrounding the deployment of artificial reefs in the Florida Keys.

Another element of best practices is the management of the site once it has been deployed. The site management plan should be required as part of the discovery process and evaluated based on the goals and objectives of the project. The following discussion addresses site management problems of which decision-makers must be cognizant.

Artificial Reef Site Management

An overview of an artificial reef project would not be complete without a discussion of the decision-making problems of site management. How will the site be managed? How is the free rider problem managed, if there is one? Who is responsible for maintenance, if there is any? These are difficult questions that need to be addressed in the conceptual phase of an artificial reef project and should be part of the criteria that are addressed by decision-makers in developing best practices.

Opponents to artificial reefs argue that the success of the reef is the demise of the oceans because of the predictability of the aggregation. It has been well documented that grouper gather around structures, which make them easy targets for fisherman. Regulations within the FKNMS are specific to location and species taken; however this is a large area with only a few staff to enforce the regulations.

Artificial reefs are not cheap to deploy or maintain. Currently, entrepreneurs solicit resource assistance from local, state and federal agencies, along with private

contributions to develop artificial reef projects. Should there be a user fee – what about the "free-rider" problem? The *Spiegel Grove* for example, sells a commemorative medallion for about $10 to help in the debt. This kind of "willingness to pay" could be used as well as additional trip fees by charter boats, or even a "boat tax" by the state or county.

Regardless of the approach, site management is currently an issue as identified by the interview with the Superintendent of the FKNMS. This problem should be addressed by the petitioner at the time of conceptual development and discussed and approved by the advisory committees, thereby eliminating the management problem from the decision-makers process. The political process will not be absent from this determination, but addressing the issue at the advisory committee level is more palatable than at the decision-maker level. Incorporating recommendations is after all the responsibility of the advisory committee.

The remainder of this study is organized to demonstrate the need for a decision-making process that incorporates best practices. Chapter 3 will provide the literature review and discuss the existing artificial reef projects used in the study. Chapter 4 will provide an "overview of paradise" and introduce the Florida Keys and the Florida Keys Marine Sanctuary, illustrating the unique ecological and socioeconomic environment binding decision-makers. Chapter 5 discusses the impact realms of artificial reefs through two distinct, yet symbiotically connected realms – economic and environmental. Chapter 6 analyzes the artificial reef decision process used in the three artificial reef examples along with the Hazen & Sawyer Report and the NOAA Study. Chapter 7

identifies the foundation for comprehensive planning and growth in the Florida Keys with a brief discussion of the protocol developed in partnership with the State of Florida. The chapter also identifies existing Monroe County artificial reef development policy utilizing the existing decision-making process. It introduces the decision-making model utilizing a best practices decision-making matrix identified through the literature and interviews based on a disaggregate method of analysis – the Goeller scorecard. Chapter 8 concludes the study with a summary of the previous chapters, the prognosis for future artificial reefs in the Florida Keys and addresses the limitations of the study.

Chapter 3
INTERVIEWS AND LITERATURE REVIEW

To assist in understanding the method discussed above, Chapter 3 provides literature review and more detail of the interviews with the key decision-makers. This area of study has important implications to the management of the Florida Keys as the decisions made concerning the FKNMS and the growth management of Monroe County are connected links in the chain of life. As the following discussion will demonstrate, there is a void in the scholarly study of decision-making processes in the Florida Keys. Ecological and socioeconomic research should be ongoing in this region to understand the shifting dynamics of this unique environment.

Literature Review

A literature review reveals that there is little study about the demand for artificial reefs and the relationship with the local governmental decision-making of these projects in the Florida Keys, or the rest of the world for that matter. Most studies that have been conducted focus the discussion on the predominant reef-use activity - commercial fishing. For example, Simard (1997) conducted studies in Japan of the socioeconomic implications of artificial reefs and their impact on commercial fish stocks. It could be argued that these new attractions only shuffle dollars already marked for the area. The *Spiegel Grove* references the Hazen & Sawyer Report as socioeconomic evidence to support their proposal, but does not fully explain the studies findings or its applicability to their project. None of the recent artificial reef projects in the Florida Keys discuss the submission, and consequently the decision-making process of their requests.

The Economic Benefits of Artificial Reefs: An Analysis of the Dade County, Florida Reef System, Florida Sea Grant College Program, University of Florida - 1988

The first study to address user benefits and the economic impact of artificial reefs in Florida was done by the Florida Sea Grant College Program, part of the University of Florida. Walter Milon was the lead researcher and his study addressed the question "How popular are the artificial reefs in Florida's largest county, Dade County and what is their value to fishermen and divers – and their economic benefit to the community as a whole?" The method used a survey to collect the data over a six-month period. Researchers mailed the survey to about 3,600 registered boat owners in Dade County and received about 1,600 responses. The survey design was focused on how often the boaters visited artificial reefs and their activities there, as well as user demographics and boat specifications. The data were analyzed using a variety of statistical methods. The study concluded that under a third of the fishermen who responded to the survey actually fished on the artificial reefs, while 13 percent of the divers who responded said they made diving trips on artificial reefs. The survey indicated that the reef users and non-reef users would be willing to pay for new artificial reefs. The study estimated the economic benefit to the county's artificial reef system at between $17.5 and $128.3 million. This conclusion does not include the value of the reefs to operators of charter fishing and diving boats as the surveys were only sent to registered private boat owners, only in Dade County thereby leaving out the value to commercial and "visitor" reef-users.

This study is used in later research and in principal can transfer some of the findings to the Florida Keys. However the material is dated and although the

generalization can apply to the reef-user assumptions in the Florida Keys, the uniqueness of Florida Keys prevents applying the conclusions. The study's use of mail survey's to registered boat owners is the foundation of the data collection methods used in the later studies and provide a template for the Hazen & Sawyer Report method.

The most significant literature that applies to this dissertation comes from three studies. A similar study on the socioeconomic impacts of artificial reefs in Northwest Florida by Bell, et al. (1998) provided some data helpful in the interpretation and composition in the Hazen & Sawyer Report (NOAA, 2003). The information is addressed in the Hazen & Sawyer Report and is therefore not discussed here. The second study "Use Value of New Artificial Reefs off Miami-Dade" by Milon (1988) provides some insight to reef-use value determination of resident boaters of Dade County. This information is also referenced in the Hazen & Sawyer Report but the information was not considered current enough to use in the report's analysis. The third study is the Hazen & Sawyer Report/NOAA Study itself. In discussing existing research these two bodies of work are combined as they are the culmination of one project. The Hazen & Sawyer Report collected the data and the NOAA Study analyzed and transferred the findings into a report; together they represent the most comprehensive research of its kind. As mentioned earlier, this study is the source for most of the data discussed here.

The Hazen and Sawyer Report Socioeconomic Study of Reefs in Southeast Florida

The Hazen & Sawyer Report discussed the demand for artificial and natural reefs in the four counties mentioned earlier. The focus of this dissertation is Monroe County and will only address information applicable for that locality. The demand by users of

reef systems identifies the economic impact created by reef-use, revenues of hotel and restaurants, for employment, wages, etc. of both resident and visitors. The overt market spending demonstrated a direct impact of expenditures and sales of $466 million and an employment of 9,984 residents for 2001.

The only research that applies direction for the development of an artificial reef program in the Florida Keys is the Hazen & Sawyer Report/NOAA Study published 2001 with a supplement for Monroe County in 2003 which has incorporated similar precursor studies in Florida. Because of the age of the studies, many of the generalities and conclusions don't apply directly, but they do provide some insight into the continuum of research on the topic. The Hazen & Sawyer Report represents the only comprehensive survey-based data collection that provided NOAA the necessary information to analyze the socioeconomic impacts in the Florida Keys. The culmination of previous studies combined with the new research formed the conclusions that are applicable today and provide the baseline for future project designs. The Hazen & Sawyer Report and the NOAA Study are primarily focused on the market use values and socioeconomic impacts of reef use. Although the focus of this dissertation is decision-making for artificial reefs, it is important to have empirical data on other factors that can influence the decision-making process. This is where the existing studies discussed here are applicable as they will help formulate an understanding of the weaknesses from exclusively using such a method to evaluate an artificial reef, or any other reef-use project in the Florida Keys.

In addition to the Hazen & Sawyer Report there are three existing artificial reef projects similar enough in scope to be used in this discourse, two of which are in the Florida Keys.

Other data sources include the "Business Plans" and "Perspectives" from the *HMS Yukon, USS Spiegel Grove*, and the *USS Vandenberg*. These documents illustrate how their proposals used loose anecdotal justification for their projects. Building on the success of the previous project, the following project would influence decision-makers with the anticipated economic success of the other projects. These artificial reef projects are discussed in detail in Chapter 6, Existing Studies.

It is apparent by the literature that best practices are not recognized in the decision-making process. The previous studies did not address decision-making in the context of best practices as identified in Chapter 2. Understanding the uniqueness of the Florida Keys is important in recognizing the decision-making climate. Chapter 4 describes the Florida Keys and the Florida Keys National Marine Sanctuary to illustrate the ecological and socioeconomic uniqueness of this region to better understand the difficulties facing decision-makers

The interviews were illuminating as to the lack of protocol in the decision process. In addition, the interviews identified the need for more comprehensive input by advisory committees as well as burdening the applicants to provide better goals and objectives from which projects will be evaluated. Chapter 3 will also provide a discussion of the existing literature concerning artificial reefs, at large and in the Florida Keys. Although there was no literature on the decision-making processes for artificial

reefs, literature did exist that provided background and information to decision-makers. Also, the existing literature did provide data for elements of this study such as method and theory.

The Interviews

Three interviews at different levels of decision-making in artificial reef proposal review were conducted as part of the research of this dissertation. Mr. George Garrett, Director of Marine Resources for Monroe County; Mr. Billy Causey, Superintendent for the FKNMS; and Mr. George Neugent, Monroe County Board of County Commission (BOCC) and member and six-time Chair of the SAC provide collaboration for the hypothesis that there is a lack of an organized approach to decision-making for artificial reef projects and other natural resources, a process that does not follow best practices. These interviews demonstrate the fragmented approach with different priorities used by each level of decision-making. The lack of an established policy or protocol and process is detrimental in determining the appropriateness of an artificial reef project which results, in some cases, in poor decisions and/or unintended consequences. For example, Mr. Causey related an artificial reef projects in the FKNMS that was approved only to discover that no provision to prohibit taking of target species were provided in the request or approval. As a result, all projects must have a “no take” provision in order to get a favorable endorsement by the SAC or FKMNS permit. An established protocol may have prevented this unintended consequence and the public’s perception of artificial reefs in the FKNMS.

To understand the current discovery process used in providing information to the decision-makers it is necessary to recognize the projects' evolution. A sample continuum for the submission of an artificial reef project is as follows:

- A project is conceptualized by either an entrepreneur or government entity
- A vessel is procured from the U.S. Navy or MARAD
- A governmental sponsor is received
- A site is selected
- ACOE and NOAA permits are requested
- Local political support is sought[2]
- A conceptual plan is presented to the governing body (BOCC) through the advisory committee's
- An application is submitted to Monroe County with necessary endorsements (e.g. ACOE, Florida Department of Environmental Protection (DEP)
- A staff report is prepared with recommendations/alternatives based in input from other permitting agencies, emphasis from the FKNMS report for their jurisdiction.
- Reports are, or should be provided by TDC, DAC, and SAC via the FKNMS report
- A series of public hearings are conducted by the different bodies including the BOCC that will include testimony from a variety of sources
- Finally, a decision is made by the BOCC

[2] Local political support takes the form in Monroe County including Federal, State, and local levels of government, lobbyists, stakeholder groups, and locally from BOCC to the public. Key groups include the Tourist Development Association (TDA), Development Acquisition Committee (DAC), FKNMS and the SAC, local environmental groups, local businesses, the project's community, and Monroe County staff.

The following summary of the interviews provide a snapshot into the existing decision-making process. Common themes of the decision-making process will be discussed as a conclusion to this discussion. The interviews asked a series of questions that utilized a likert scale to measure the satisfaction level of the decision-making process, among other areas. The interviews were recorded and asked questions from a standard questionnaire. The same questionnaire was used for each interview; however, respondents expanded responses of some questions they felt required expanding. The interviews were conducted by the author of this study.

Mr. Billy Causey, Superintendent of the Florida Keys National Marine Sanctuary

Local Government Impact: There is a very high value placed on the input provided by local government in the form of formal input (reports) and informal input (conversations). The FKNMS primary concern is for the biological impacts that an artificial reef project may have. The FKNMS does not consider user value or socioeconomic criteria as part of the formal decision-making process; however, Mr. Causey did state that socioeconomic factors do play a part in the final determination as to the peripheral criteria of the decision-making process. The FKNMS uses the ecological, biological impacts to the health and sustainability as the primary factors in the decision-making process.

Use Value Method: The FKNMS does not utilize a valuation method in the decision-making process. When socioeconomic considerations are made, Mr. Causey stated that the decisions are made anecdotally from input by other in the decision-making stream such as the TDA and DAC. In addition, other examples of impacts are considered such

as those of "Wreck Alley" off of the San Diego, California coast[3]. As data are collected from the post-deployment evaluation of the *Spiegel Grove*, the decision-making process will be able to rely on empirical, local data.

Alternatives: Mr. Causey stated that having a tool that included non-market user value would be very helpful in the decision-making process. Providing a tool that incorporated best practices including a hybrid valuation method would assist decision-makers and provide richer evaluation criteria for the decision-making process. Although Monroe County does a good job in its decision-making process, the limited criteria and non-scientific method results in gaps that can take a great deal of time to resolve.

Mr. George Garrett, Director of Marine Resources, Monroe County

Local Government Impact: Mr. Garrett stated that the staff has moderate influence on the decision-making process. Mr. Garrett feels that this is primarily a political decision that is ultimately made by the BOCC. In providing input to decision-makers, a baseline economic consideration is derived by the 2003 NOAA study and qualitative values such as stewardship are also involved in the reports. Determining the level of significance of these values is done without the benefit of empirical data and is arrived at based on individual perspective from education and experience.

Use Value Method: Mr. Garrett stated that use value is derived from the NOAA 2003 study which is a Travel Cost Method of determining use value. However, after a description of other use valuation methods, Mr. Garrett acknowledged that Contingent Valuation better represents his preference for a valuation method. Since non-market

[3] Wreck Alley is a series of artificial reefs placed off of the San Diego, CA coast for socioeconomic purposes. The most notable of these wrecks is the *USS Yukon* because of its size and publicity.

values such as stewardship are a peripheral consideration, albeit a very low priority, Contingent Valuation may better describe the valuation method used by Monroe County.

Alternatives: Mr. Garrett stated that non-market user value would be very helpful in the decision-making process for Monroe County. The data would best be applied through a matrix that identified a hybrid method that incorporated the Travel Cost Method and the Contingent Valuation method because of comprehensiveness. Mr. Garrett feels that because the decision-making process is political and requires public hearings that notify the community of potential development/artificial reef projects, and that the permitting of such a project requires multi-agency approvals, that the Monroe County decision-making process is adequate but could be improved.

Mr. George Neugent, Monroe County BOCC and SAC Member

Local Government Impact: Mr. Neugent feels that there are many levels of input through the establishment of advisory committees such as the TDA and DAC. In addition, input by other agencies gives significant insight as to the appropriateness of a project within the county. Mr. Neugent feels that staff provide an adequate report as to the project's impact from a growth management perspective and ensures all regulatory requirements have been met. Mr. Neugent identifies the roll stakeholders play in the decision-making process but is adamant that the safety of the Sanctuary is the foremost consideration in the decision-making process.

Use Value Method: Mr. Neugent acknowledges that socioeconomic impacts are considered in the decision-making process juxtaposition with the surrounding reefs. Identifying a particular use value method is not a necessary step as many different

elements are involved in the decision-making process. However, if a national baseline dataset did exist and identified non-market values that could be used to buttress support by state and federal agencies, then such a model would be useful. Monroe County is unique in many areas and it would be difficult to fit all the concerns into one box.

Alternatives: Mr. Neugent stated that a model or decision-making process that could be adopted as policy would provide consistency and eliminate litigation by establishing a non-arbitrary process. Acknowledging socioeconomic, ecological/biological, and non-market considerations would be an asset. However, the process itself is where Mr. Neugent feels the most benefit would be realized. Investigation and analysis by committee and expert testimony at public hearing would provide the greatest benefit to the decision-making process.

Summary: It is clear that each level of decision-making does not have an established process. Each level recognizes a need for consistency but has different ideas where the priorities should be placed. In addition, it is also clear that a model or established protocol affirmed in policy would be extremely beneficial in the establishment of a consistent decision-making process for artificial reefs and other decision-making projects.

Chapter 4
OVERVIEW OF PARADISE

Decision-makers in the Florida Keys have much to consider, as do all decision-making officials. Economics, tourism, community character, posterity – it can be overwhelming. Understanding the environment in which these decisions are made is paramount to success. This Chapter will illustrate the Florida Keys and the marine sanctuary that protects the waters around this extraordinary collection of islands to provide an overview of some of the difficulties facing decision-makers.

The Florida Keys' Identity

The Florida Keys have two distinct, yet similar identities. In the human setting use and development of the limited resources create a chaotic landscape of buildings, roads, cars and boats. The natural setting is critical to the intricate web of life in the region where the landscape is serene and the only disturbance comes from a pelican diving for its supper or the wind stirring the mangrove branches. This juxtaposition makes for animated debate between environmentalists and developers during public hearings when a proposed development is on the agenda.

What are the "Florida Keys"? How is the environment of the Florida Keys managed? What is the landscape of the Florida Keys, and what are the threats to their survival? Below is a snapshot of the Florida Keys that provide an overview of the parts that help define the whole. The diversity of ecosystems and recreational opportunities help illustrate why this region is so popular with residents and visitors. In addition, some

discussion is provided as to the socioeconomic uniqueness of the Florida Keys and the important role artificial reefs can play in their survival.

The Built Environment

Demographics

The population of Monroe County in 2000 was 79,589 with approximately 30% or 24,000 residents living in the City of Key West. In addition to resident populations, millions of tourists also enjoy visiting "Paradise" and provide the major source of employment for local residents. Retail services, commercial fishing and government employment make up the other industries. Nestled in the turquoise-blue waters, among sensitive coral reefs and highly productive marine nurseries, the Florida Keys are an international Mecca for sport fishing, diving, boating and relaxing (Monroe County 2010 Comprehensive Plan 2003).

A significant portion of the surrounding water has been designated as Outstanding Florida Waters and includes the FKNMS. Despite this, most wastewater demands in the islands are served by onsite septic systems and modernization to central systems is badly needed. The Florida Keys are a place of contrast as visitors arrive daily to dive on the only living reef system in the continental U.S., visit historic sites in one of America's largest historic districts, enjoy the laid back tropical atmosphere, party during one of the many Florida Keys-wide festivals, and pull in prize sport fish. This popularity results in the building of expensive homes, displacing affordable workforce housing, while the county struggles to meet infrastructure demands. Monroe County now has the second highest cost of living in the State of Florida and instead of demanding more economic

development, business leaders urge for affordable housing to accommodate a workforce of close to 44,000 with a median housing cost of $241,200 (FKCCS, 2003). It is difficult to keep traditional communities intact when even professionals, such as teachers, police officers and county employees cannot afford homes or rents, although median family income is over $55,000 per year.

Socioeconomic Uniqueness

The Florida Keys are unique on many levels, the obvious being their geography. As a chain of small outcrops of land protruding to divide the Gulf of Mexico and the Atlantic Ocean, this group of islands forms a unique collection of natural resources. Recreational use of the natural resources is the primary source of revenue for this region with little other income for residents. Although there is some revenue generated by taxes, non-reef use such as kayak tours through the mangroves, airplane tours, and jet-skiing, the most significant revenue for residents and the localities come from reef-related use.

The data for the following comes from the Hazen & Sawyer Report which used information gathered from Monroe County, Department of Marine Resources and the Department of Tourism and the Florida Statistical Abstract for 2001, as well as other statistical data as cited, to supplement their surveys.

The Hazen & Sawyer Report found that the reef industry generated wages for Monroe County in the amount of $19.1 million (2001 dollars). According to the U.S. Department of Commerce, Bureau of Economic Analysis (non-farm earnings), reef-related activities provided $233.8 million in revenue, 16.1% the total employment for the

county; the following data illustrates the significant roll the reef-related industry plays in Monroe County.

Economic Contribution of Reefs to Monroe County from June 2000 to May 2001

Sales	Income	Employment (FT and PT Jobs)
$504 million	$140 million	10,000

Therefore, the failure to protect the reef resources could create a catastrophic economic failure affecting the diversity of businesses from dive shops to real-estate.

So what would create a decline in this revenue and create such a situation? If the health of the reef is diminished, presumably by too much use from too many users, then the number of users will decline because the user will look for more attractive substitutes such as other reefs or different activities. The number of reef-related users, primarily those visiting that require secondary services such as lodging, provides for the Florida Keys' economic stability. It is incumbent on the decision-makers to ensure that people still want to visit and "use" the reefs. Artificial reefs can provide a solution to this problem, as well as adding additional benefit by improving the health of the other reefs through eliminating or reducing the stress from overuse.

Looking to the future, what should be considered for the socioeconomic survival of the Florida Keys? If we accept the premise that, all other things being equal, the only variable that would affect use is the increasing population, then the existing carrying capacity of the reef system has probably been exceeded. This conclusion is drawn from the Hazen & Sawyer Report surveys and the NOAA (2003) analysis that alludes to the

level of use of the reef system during the study period already exceeding the carrying capacity (*Ibid*). Considered together, declines in both resident and visitor use could irreparably damage the socioeconomic health of the Florida Keys. Therefore, since natural reefs cannot be developed in a short period of time, artificial reefs are the most effective method of addressing diminished carrying capacity and ensuring the economic stability and growth.

The homogenous economy of the Florida Keys makes the economic dynamics unique. Other tourist-based communities don't face the combination of isolation, sole-source reliance of revenue, and a tenuous natural resource which doubles as the most significant attraction for visitation. Unlike seasonal communities such as Aspen, CO or Myrtle Beach, SC the Florida Keys rely on the steady stream of visitation that is the annual revenue source for residents and businesses.

In sum, for Monroe County the annual reef use value (2001 dollars) was $9.75 million (NOAA, 2003). With the events of 9/11 and the projected growth in the resident population of Monroe County, an increase in use should be projected and planned for. Government management is necessary to ensure that the artificial reef project remains successful; that is, it is being used for the purpose it was created for. At a minimum, maintaining the level of use will provide a higher user value, whether measured by the amount of money users willing to pay or expressing their value in non-market terms (NOAA, 2003). The Hazen & Sawyer Report stated that for every dollar spent on the management of all reef activities by government in Southeast Florida, $23 is generated in

use value flowing from the reef users. Therefore, managing an artificial reef properly ensures a continued level of use that could provide continued economic growth.

Florida Keys National Marine Sanctuary

To protect the reef system of the Florida Keys several programs have been adopted to manage the dynamic ecosystem. The following discussion addresses the most significant attempt, the FKNMS.

Human Setting

Background. The lure of the Florida Keys has attracted explorers and visitors for centuries. The clear tropical waters, bountiful resources, and appealing natural environment were among the many fine qualities that attracted visitors to the Florida Keys. However, warning signs that the Florida Keys' environment and natural resources were fragile, and not infinite, came early. In 1957, a group of conservationists and scientists held a conference at the Everglades National Park and discussed the demise of the coral reef resources in the Florida Keys at the hands of those attracted there because of their beauty and uniqueness. This conference resulted in action that created the world's first underwater park, the John Pennekamp Coral Reef State Park, in 1960. However, in just a little over a decade following the establishment of the park, a public outcry was sounded that cited pollution, over-harvesting, physical impacts, overuse, and use conflicts as continuing to occur in the Florida Keys. These concerns continued to be voiced by environmentalists and scientists alike throughout the decade of the 1970's and indeed, through today (FKNMSMP, 2005).

Other management efforts were instituted to protect the coral reefs of the Florida Keys. The Key Largo National Marine Sanctuary was established in 1975 to protect 103 square nautical miles of coral reef habitat stretching along the reef tract from north of Carysfort Lighthouse to south of Molasses Reef, offshore of the Upper Florida Keys. In 1981, the 5.32 square nautical mile Looe Key National Marine Sanctuary was established to protect the very popular Looe Key Reef located off Big Pine Key in the Lower Florida Keys. Throughout the 1980's mounting threats to the health and ecological future of the coral reef ecosystem in the Florida Keys prompted Congress to take action to protect this fragile natural resource. The threat of oil drilling off the Florida Keys in the mid to late 1980's, combined with reports of deteriorating water quality throughout the region, occurred at the same time scientists were assessing the adverse effects of coral bleaching, the die-off of the long-spine urchin, loss of living coral cover on reefs, a major sea grass die-off, declines in reef fish populations, and the spread of coral diseases. With the reauthorization of the National Marine Sanctuary Program in 1988, Congress directed the Sanctuary Program to conduct a feasibility study of possible expansion of Sanctuary sites in the Florida Keys. Those study sites were in the vicinity of Alligator Reef, Sombrero Key, and westward from American Shoals. This endorsement for expansion of the Sanctuary program in the Florida Keys was a Congressional signal that the health of the resources of the Florida Keys was of national concern. The feasibility study was overtaken by several natural events and ship groundings that precipitated the designation of the FKNMS (*Ibid*).

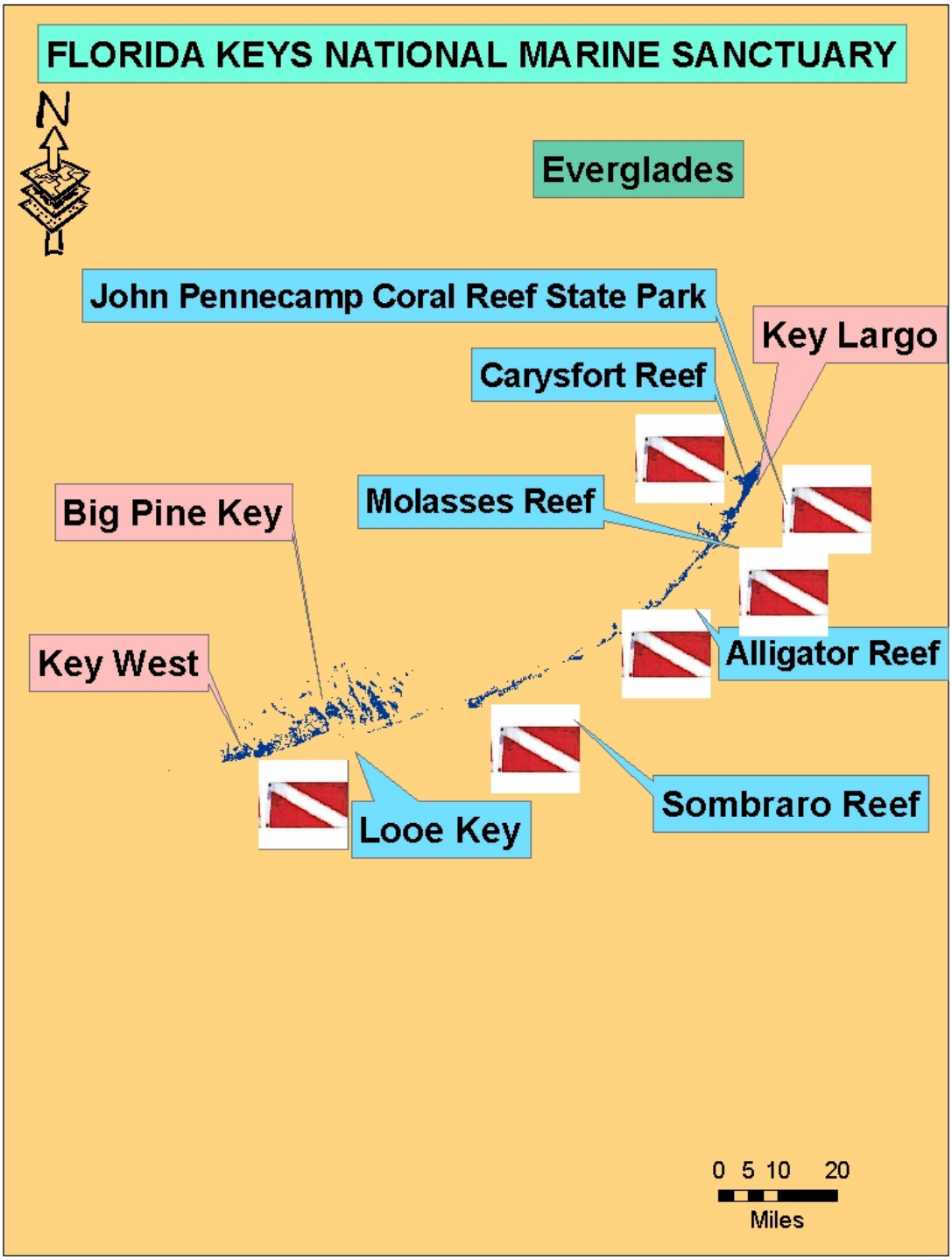

Figure 7 Bookmarks of the Florida Keys National Marine Sanctuary

Three ships ran aground on the coral reef within a brief 18-day period in the 1989 (NOAA, 2003); it was this final physical insult to the reef that prompted Congress to take action to protect the coral reef ecosystem of the Florida Keys. Although most remember the ship groundings as having triggered Congressional action, it was in fact the cumulative events of environmental degradation, in conjunction with the physical impacts of use such as broken coral and mangrove deforestation that prompted Congressman Dante Fascell to introduce a bill into the House of Representatives in November of 1989. The bill was sponsored in the Senate by Senator Bob Graham, also known for his support of environmental issues. It was passed by Congress with bi-partisan support and was signed. On November 16, 1990, the President signed into law the Florida Keys National Marine Sanctuary and Protection Act (FKNMSMP, 2005).

According to a 1998 report issued by NOAA's Ocean and Coastal Resource Management Coastal and Ocean Resources Economics Study, the economy of the Florida Keys is dependent upon a healthy reef ecosystem (NOAA, 2003). Approximately four million tourists visit the Florida Keys annually, participating primarily in water-related sports such as fishing, diving, boating, and other water dependent activities. In 1991, the gross earnings of the Florida Keys and Monroe County totaled $853 million, 36 percent of which came from services provided as part of the tourism industry. Another 18.7 percent of the gross earnings came from the retail trade, which is largely supported by tourists. In 1990, half of the Florida Keys' population held jobs that directly or indirectly supported outdoor recreation. In addition, the commercial fishing industry accounted for $17 million of the Florida Keys' economy, more than 20 percent of Florida's total gross

earnings from commercial fishing. All of these activities depend on a healthy marine environment with good water quality.

The FKNMS is managed by a Board of Directors comprised of a combination of state appointments and dedicated placements such as a representative from the Monroe County Board of County Commissioners. The FKNMS Board of Directors is comprised of representatives from NOAA, Florida Department of Fish and Wildlife, and Monroe County. Therefore, the FKNMS has the resources to provide invaluable input the research of a proposal and provide guidance to decision-makers.

The "Natural" Setting

Environment of the Florida Keys. The Florida Keys are a 220-mile long chain of islands that extend from the southeastern tip of the Florida peninsula to the Dry Tortugas. The islands lie between the Gulf of Mexico and the Atlantic Ocean, stretching to within 90 miles of Cuba. The highest spot along these islands is only 18 feet above sea level and there is no point that is more than four miles from water. Only about 30 of these 822 islands are inhabited. The more developed islands are connected by a narrow ribbon of U.S. Highway 1 and are spanned by 19 miles of bridges. Along this stretch of highway is an eclectic mix of residential areas, tourist attractions, marinas, shops and restaurants surrounded by some of the most unique and endangered habitat and species in the world.

The natural communities of the Florida Keys rest on the eroded foothills of the ancient Appalachian Mountains now covered with fossilized reefs and limestone banks. In response to unique island conditions, isolation and colonization from the Bahamas and West Indies, many rare and endemic species have evolved in the Florida Keys. Over 30

of these plants and animals can be found only in the upland habitats, hammocks and pinelands of the Florida Keys and nowhere else in the world. Miami, a leading international commerce and tourist capital, and Miami-Dade County with a population of over 2 million people, are located just an hour away. With such pressures, development in the Florida Keys has already displaced nearly half of the upland habitat and a number of endangered species are threatened with extinction (FKCCS, 2003). Over half of the remaining land in the Florida Keys is now in public ownership and managed for preservation with a critical need for acquisition of the remaining habitat areas.

FKNMS Environment

The FKNMS boast spectacular, unique, and nationally significant marine environments, including sea grass meadows, mangrove islands, and extensive living coral reefs. According to NOAA's environmental impact statement for the FKNMS (2003), the marine environment of the Florida Keys supports over 6,000 species of plants, fishes, and invertebrates, including the Nation's only coral reef that lies adjacent to the continent, and one of the largest sea grass communities providing habitat for several endangered species as well as nurseries for juvenile fish and other marine life (NOAA, 2003). The following discussion of anthropogenic impacts provides a look at some of the issues.

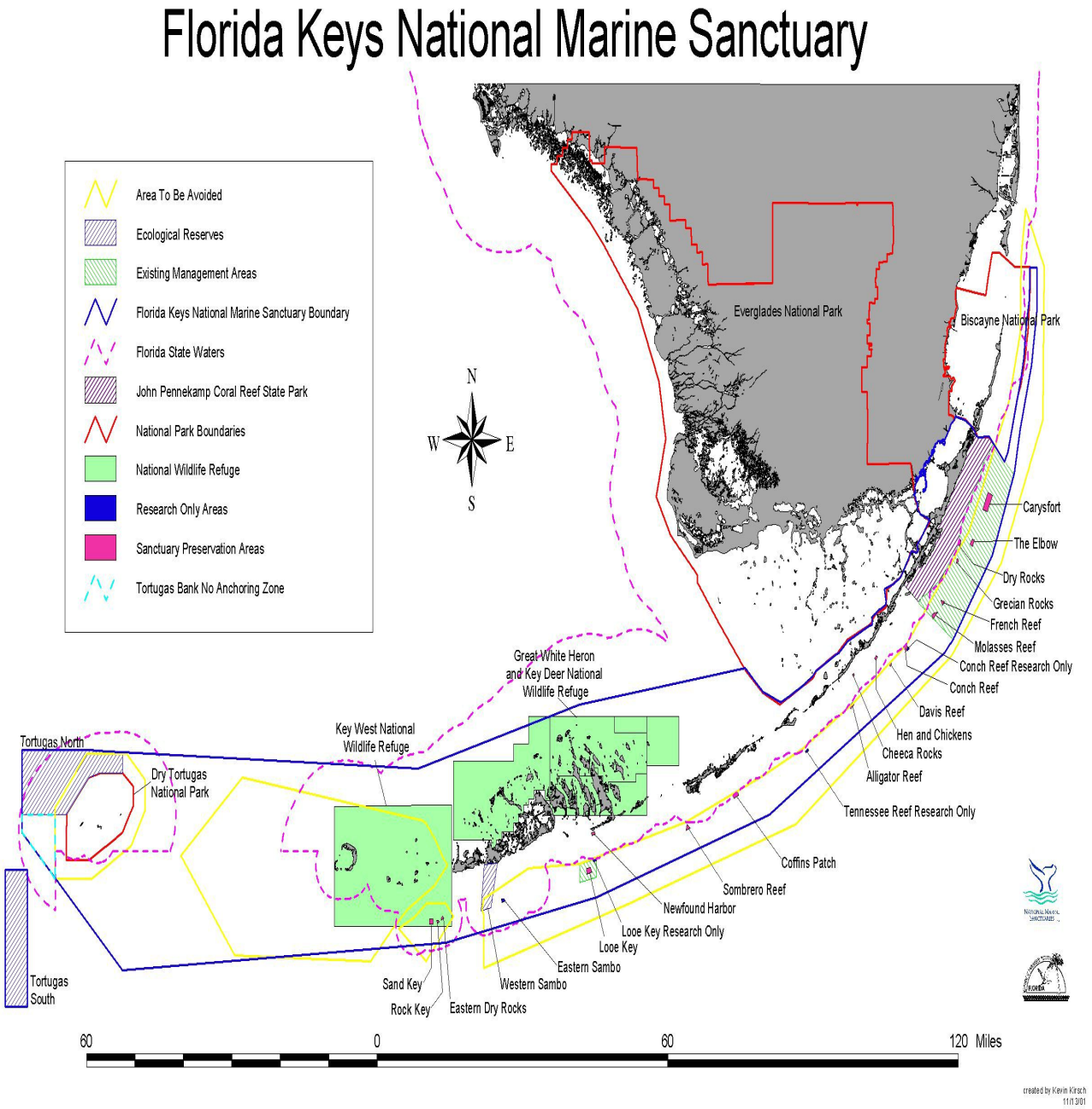

Figure 8 Map of FKNMS from NOAA Study, 2003

Chapter 5
IMPACT REALMS

Impacts

What are the impacts of artificial reefs? This is an essential question for decision-makers as the answer could have a significant influence on their review and ultimately on the decision. There are two types of impacts discussed here: Economic impacts and environmental impacts (direct and indirect human impacts). The overview of impacts discussed here provides a cursory discussion of some of the concerns decision-makers must address when considering artificial reef projects.

Economic Impacts

Essential to the decision-making process is an understanding of the economics involved. As discussed above, socioeconomics have a tremendous impact when considering a project because the economic effect on the community. Economics looks primarily at market use value in order to quantify and measure a monetary value to be placed on a project. So, what are the economics of artificial reefs? The question is what use value do artificial reefs have to those who use them? Although this value will vary and be determined by diverse qualitative factors, the important objective is to identify the concepts of economics to be used in an evaluation.

As discussed earlier, the traditional method of use valuation is monetarily driven as demonstrated by the WTP and TCM models. However, non-market considerations must also be addressed as identified in the interviews. Non-use values are critical in the decision-making process because they not only reflect a non-use willingness to pay as

demonstrated by donations to groups such as the Dolphin Research Center and the FKNMS during fundraising campaigns, but can also have a significant political impact as demonstrated by national and local environmental advocacy groups such as the World Wildlife Fund and locally, Florida First – two groups that have had significant impacts to the increased litigation experienced by Monroe County in response to development and growth management issues.

A literature review reveals that there is little study about the demand for artificial reefs and the relationship with the socioeconomic efficacy of these projects in the Florida Keys, or the rest of the world for that matter. Most studies that have been conducted focus the discussion on the greatest reef-building activity, usually around commercial fish populations. For example, as referenced earlier there have been studies in Japan of the socioeconomic implications of artificial reefs and their impact on commercial fish stocks (Simard, 1997). Although there is no empirical evidence to indicate that artificial reefs have a socioeconomic impact, studies that have been conducted in the Florida Keys demonstrate through the WTP model that there is a correlation between water based recreation and the economic streams of the Florida Keys. Therefore, it could be hypothesized through anecdotal evidence that developers believe there is a relationship between introducing "new" or novel areas to experience that are similar to natural occurring areas will attract users, and a study would therefore not be necessary to confirm the obvious. For example, if a naturally occurring shipwreck attracts customers, then creating the same experience artificially should have the same affect. This is the basis for both the *Yukon* and the *Spiegel Grove* projects and will be discussed later in Chapter 6.

In the Florida Keys it could be argued that these new attractions only shuffle dollars already marked for the area. This is because the economy of the Florida Keys is tourism based and most visitors are coming for the sum of the attractions, not necessarily one in particular. This justification does not address the socio aspects such as recreation, or non-use values such as stewardship or preservation of a project and those benefits received by a community from them. For example, preservation of the resource provides the desired physical environment of the residents. Would the area hold the same housing demand if the reefs were diminished?

According to the NOAA Study total reef related tourist spending in the Florida Keys during the period from June 1995 through May 96 amounted to over $80,000,000, for the June 2000 to May 2001 period total spending had risen to $356,740,857 with $82,1569,376 of that from artificial reefs alone. Artificial reefs generated 1,916 jobs and over 1,470,000 person days of activity that contributed revenue. The total income contribution (the sum of employee compensation, proprietor income, interest, rents and profits) that remained in Monroe County from artificial reef related activities was $26,695,085.

Environmental Impacts

The following information comes from the impact statement of the NOAA Study (2003) and the FKNMS Management Plan (2005). The data were collected from 1997 and therefore may not reflect current status of these resources; however, for the purpose of this overview the accuracy will suffice for providing the level of damage that exists.

The deterioration of the marine environment in the Florida Keys is no longer a matter of debate. There is a decline of healthy corals, an invasion by algae into sea grass beds and reefs, a decline in certain fisheries, an increase of coral diseases and coral bleaching. In Florida Bay, reduced freshwater flow has resulted in an increase in plankton blooms, sponge and sea grass die-offs, and fish kills (*Ibid*).

Over four million people visit the Florida Keys annually, 70% of whom visit the FKNMS. Over 80,000 people reside in the Florida Keys full time. According to the Hazen & Sawyer Report, since 1965 the number of registered private recreational vessels has increased over six times. There are significant direct and indirect effects from the high levels of use of Sanctuary resources resulting from residents and tourists. The damage done by people hinders the ability of marine life to recover from naturally occurring stresses. Human impacts can be separated into direct and indirect impacts.

Direct Human Impacts

The most visible physical damage results from carelessness and recklessness (NOAA, 2003). For example, ship captain's running into the reefs; boaters, divers, fishermen, snorkeling and beachgoers damaging coral heads or running over sea grass beds. Removal of mangroves and other habitat degradation from development add to the damage of the reef-system. Direct impacts to resources can also result from careless divers touching and snorkelers standing on coral, improperly placed anchors, and destructive fishing methods. According to NOAA's 2003 Environmental Impact Statement for the FKNMS, in the period between 1993 and 1994, approximately 500 vessels were reported aground in the Sanctuary. These groundings have a cumulative

effect on the resources; over 19 acres of coral reef habitat has been damaged or destroyed by large ship groundings (*Ibid*).

Indirect Human Impacts

The Florida Keys National Marine Sanctuary Master Plan (2005) states that the excessive nutrification of near-shore waters is a documented problem in the FKNMS. A major source of excess nutrients is sewage: 25,000 septic tanks, 7,000 cesspools, 700 shallow injection wells, and 139 marinas harboring over 15,000 boats. These nutrients are carried through the region by more than 700 canals and channels. Removing nitrogen and phosphorous from wastewater requires a technology that, at present, is lacking from sewage treatment facilities in the Florida Keys (*Ibid*). Toxins and other pollutants enter the water from runoff of the impervious surfaces such as roads and parking lots. Without controls to eliminate or reduce the contaminants entering the water, the increasing population will likely increase the amount of damage to the reefs exponentially. Biofiltration and aquatic vegetation is an established method for improving water quality before discharge (Horton, 2003).

How does a decision-maker balance the economic impacts against the environmental impacts? At what point is it required to protect the economic resource and at what cost? The greater the deterioration of the resource, the longer period of recovery and prohibited use – assuming the carrying capacity can be restored. Presumably, that would affect tourism and the economic streams. What has been the experience of previous attempts at achieving this balance? In Chapter 6 a review of existing studies of artificial reef projects and an analysis of the decision-making process is discussed.

Chapter 6
ARTIFICIAL REEF DECISION MAKING

As discussed earlier there is limited scholarly study of the decision-making process for artificial reef projects in the Florida Keys. The only research that applies direction for the development of an artificial reef program in the Florida Keys is the Hazen & Sawyer Report/NOAA Study which has incorporated similar precursor studies in Florida. Because of the age of the studies, many of the generalities and conclusions do not apply directly, but they do provide some insight into the continuum of research on the topic. The Hazen & Sawyer Report represents the only comprehensive survey-based data collection that provided NOAA the necessary information to analyze the socioeconomic impacts in the Florida Keys. The culmination of previous studies combined with the new research formed the conclusions that are applicable today and provide the baseline for future project designs. The Hazen & Sawyer Report and the NOAA Study are primarily focused on the market use values and socioeconomic impacts of reef use. Although the focus of this dissertation is decision-making for artificial reefs, it is important to have empirical data on other factors that can influence the decision-making process. This is where the existing studies discussed here are applicable, as they will help formulate an understanding of the weaknesses from exclusively using such a method to evaluate an artificial reef, or any other reef-use project in the Florida Keys.

In addition to the Hazen & Sawyer Report there are three existing artificial reef projects similar enough in scope to be used in this discourse, two of which are in the Florida Keys. Two projects have been deployed and are undergoing post-deployment

evaluation; the other is in the permitting/deployment process. A review of the business and the marketing plans of the existing projects illustrate how the decision-making process was employed.

This Chapter will discuss each artificial reef project and include the methods utilized to justify their projects, and an analysis of the method for the decision-making process. Following the discussion there will be a brief evaluation of the method identifying areas of the decision-making process that could be improved. The *HMCS Yukon* in San Diego, California and the *USS Spiegel Grove* in Key Largo, Florida have begun collecting post-deployment data that can provide some insight to evaluate the projects. Although there are other existing artificial reefs in the Florida Keys, the scope of the decision-making process is best represented by the two above-mentioned projects and the proposed *USS Vandenberg* because of their size, use, and impact to their respective communities.

Unlike the other two artificial reef projects, the third project is unique in that it is addressing both market and non-market use issues. The *Vandenberg* is scheduled for deployment as an artificial reef in late 2006 off of Key West, Florida and is an entrepreneurial venture utilizing different marketing and uses then her predecessors. For example, the *Vandenberg* is proposing to place live-feed cameras in and around the structure for use by educational institutions and research facilities. Debt recovery will be accomplished by using not only user-fees, but also creative use of the entire structure. For example, the bridge area could be identified as the “Mote Institute” Bridge with a plaque identifying its participation with the project (Reef-Makers, 2004).

The second part of this chapter is the examination of existing studies and appropriate writings. The Hazen & Sawyer Report and the subsequent NOAA Study will represent the existing method for socioeconomic impact evaluation of new artificial reefs in the Florida Keys. These studies examine a much greater scope than that addressed by this dissertation; however, it does separate Monroe County from other Counties in the studies and provides a breakdown of data specific to this topic. The Hazen & Sawyer Report and NOAA Study represent the market-use blueprint for evaluating an artificial reef proposal that provide data to illustrate the socioeconomic value of the reef-system to the Florida Keys.

The data and conclusions of the existing studies are referenced by each project to discuss their projections without collecting original data. Therefore, it is important to understand the strengths and weaknesses of this body of research through methodology to determine if alternative methods or modification to the existing method would provide a better evaluation process for decision-makers.

The Ships

HMCS YUKON

Figure 9 San Diego Oceans Foundation website found on 2/23/05 at http://www.sdoceans.org/programs/artificial_reefs/wreckalley.php

In 1996, the San Diego Oceans Foundation began a precedent-setting program to create a Master Plan for Habitat Enhancement (MPHE) for California State waters off San Diego County. The intent was to create a broad framework to fulfill the desires of fishers, divers, and scientists for more places to explore, more fish to catch, and specific sites reserved for habitat enhancement research. The MPHE was developed with four types of zones designed to serve different user needs consisting of: 1) six Kelp Enhancement Zones; 2) three Research Zones; 3) three Deep Water Economic Zones; and 4), one Shallow Water Economic Zone. The concept for an economic zone and underwater recreation area was developed to meet these goals for recreational diving,

fishing and scientific research (City of San Diego, San Diego Underwater Recreation Area and the *Yukon* Project, 1999).

The *Yukon*, sunk off the San Diego, California shore, is the largest ship ever sunk on the West Coast as an artificial reef. She is resting on her port side in 100 feet of water just 1.85 miles west of Mission Beach. She is in a location that is accessible for both divers and fishermen, which makes her a favorable recreational area. An estimated 10,000 recreational dives were made on her in the first year of her new life as an artificial reef. As a result, the tourism industry in San Diego has flourished since the sinking and because most of the divers visiting the *Yukon* are from out of town, they are spending money locally and increasing local revenues (SDOF, 2004).

The *Yukon* project objectives were primarily socioeconomic but the evaluation process was focused on the environmental impacts. Chapter Four (4.9) of the City of San Diego's project analysis describes land use and recreation as "beneficial uses" that are a focus of its regulations (City of San Diego, 1999). However, the discussion of a socioeconomic policy is absent from the evaluation. The discourse covers activities such as scuba diving, fishing, research and education, and other socio aspects of impact without identifying the importance the relationship of the project has with the activities. The only discussion of economic impacts comes from Chapter Five, Growth Inducement that identifies growth in reef-use industries such as diving and fishing, associated industry, support facilities such as hotels and restaurants, and related areas. The City of San Diego created Wreck Alley for socioeconomic purposes; however the decision-making process is not available to determine if any goals were established. It could be

argued by the establishment of this recreation area that the goals were socioeconomic in nature and the decision-making process for future deployments is evolving with environmental considerations becoming more of a public concern (*Ibid*).

Figure10 San Diego Oceans Foundation website retrieved on 2/23/05 at http://www.sdoceans.org/programs/artificial_reefs/wreckalley.php

In the fall of 2002, San Diego Oceans Foundation (SDOF) proposed a study to determine what effects the *Yukon* has had on the tourism in San Diego. With the help from the San Diego Convention and Visitors Bureau, the SDOF drafted a questionnaire to

determine its socioeconomic benefits. From September to December 2002, each dive operator in San Diego was responsible for having all *Yukon* divers complete the questionnaire. The surveys were collected and turned over to SDOF for statistical analysis. Although the analysis indicated a significant increase in visitation, the socioeconomic variables differed from the Florida Keys and therefore only generate a low level of confidence in the transferability of conclusions. Primarily, the Florida Keys rely on the reef system for their economic survival. Also, because of the relative isolation of the Florida Keys, leisure and other socio aspects rely on the reef system. San Diego has many options for both socio and economic uses and that diversity requires less dependency on the success of an artificial reef project. However, the *Yukon* does demonstrate that large ships as artificial reefs are used as intended and can therefore be successful. The SDOF reported that the *Yukon* project resulted in an increase of recreational use of the artificial reefs in the area known as “shipwreck alley” of 30% to 40% (ABC News, 2000). Specific goals and objectives need to be evaluated to determine the level of success the project achieved.

Although industry stakeholders representing potential users proposed the project, evaluation criteria did not include a discussion of the socioeconomic elements that would be necessary to ensure the projects goals could be measured. Establishment of a clear decision-making process could ensure concerns are addressed pre-deployment and adequate measurement is conducted post-deployment.

Analysis Method

The omission of socioeconomic evaluation is a critical flaw in the *Yukon's* method in the decision-making process. Using anecdotal data, the project developers marketed the project as a volunteer effort to bring an additional fishing/diving attraction to "wreck alley", an area of intentional shipwrecks for the purpose of recreation. Working with the Artificial Reef Society of British Columbia, as well as other organizations, the SDOF prepared an Operation Plan that discussed the procedures to be followed with the anticipated benefits the community would receive. This process included a detailed Environmental Impact Report by the City of San Diego that produced an evaluation of the potential impacts of the project. The report only briefly discussed the socioeconomic impacts describing additional recreational activities and "growth inducements" (City of San Diego, 1999).

Environmental impacts notwithstanding, a decision-making method addressing the use of large ships as artificial reefs requires an analysis of the socioeconomic impacts such a project would have. To evaluate whether the project is a success, there must be evaluation of the stated goals and objectives. The *Yukon* is designated as a "Recreation Area", yet there is no discussion of how the project has been used. The report recommends that a statistical analysis of surveys distributed by charter boats be conducted to evaluate use; however there is no discussion of the development of the surveys or the method to be used in evaluating the socioeconomic impact.

A hybrid contingent valuation method would allow the City of San Diego to develop a decision-making process that could determine the level of success the *Yukon* is

having. Such a method would provide for a level of measurement useful for the determination of future projects in San Diego's Wreck Alley and in other similar areas. SDOF is conducting a post-deployment study that will address two aspects of the project. An environmental analysis is scheduled to be conducted by the Scripps Institute of Oceanography and an economic report will be prepared by UCLA originally with an expected published date projected for November 2004 (SDOF, 2004); as of this date it has not yet been published.

The *Yukon* project is used as an example for many other projects including the *Spiegel Grove* and the *Vandenberg*. The *Yukon* provides an example of a large ship intentionally sunk for the purpose of an artificial reef. Localities with future artificial reef projects can learn from the trial and error method used by the *Yukon* to create a policy that will provide a method that includes evaluation to effectively monitor the impacts of a project and determine if the project is accomplishing the goals it was designed for. However, as discussed below, the *Spiegel Grove* did not benefit from the Yukon's experiences and endured the arduous lessons of inadequate planning.

USS SPIEGEL GROVE

Figure 11 Spiegel Grove.com website found on 2/23/05 at http://www.spiegelgrove.com

The *USS Spiegel Grove* is a 510 foot obsolete military vessel and was deployed as the largest intentionally placed artificial reef offshore of Key Largo, Florida in June 2002. The primary objective for deploying the ship was to determine if scuba diving use on adjacent natural reef sites could be reduced through the placement of an artificial reef. The secondary objective was to stimulate the local economy of Key Largo through increased diving related tourism (Key Largo Chamber of Commerce Artificial Reef Committee, 1997).

The *Spiegel Grove* project evolved from a similar 1987 artificial reef project; two Coast Guard Cutters (*USCGC Duane* and *USCGC Bibb*) were intentionally sunk as dive attractions off of Key Largo with the primary objective of stimulating the local tourism

economy. The *Duane* and the *Bibb* are considered an economic success, coupled with concerns that the natural reef system was experiencing deterioration from increased use the earlier artificial reef projects demonstrated the potential for use relief and assist in recovery. In addition, the projects provided a point of reference for the locality to begin developing a proposal and plan for future projects (*Ibid*).

Although the *Spiegel Grove* project's primary objective was stated as an attempt to help the surrounding natural reefs, the proposal focused on socioeconomic impacts. Described as an economy almost entirely tourism based, Key Largo relied on the economic benefits suggested by the Hazen & Sawyer Report to endorse and validate the project. The project's proposal referenced the Hazen & Sawyer Report stating that the study "indicates a strong correlation between reefs and the economic activity generated from their existence" (*Ibid*, pg. 5). The proposal further estimated that Monroe County would generate a 20% increase in artificial reef related recreational activity. The proposal stated that the 20% increase would produce additional sales revenue of $25.4 million and 400 new jobs, as well as $380,000 per year to the county in sales tax collections. Using the Hazen & Sawyer Report and the experiences of the *Yukon*, the proposal stated they felt their estimates were conservative and that the actual revenue would most likely exceed the estimate.

Financing of the project utilized two revenue streams; grants and a user fee in the form of voluntary contributions. The user fees represent a willingness to pay and are materialized in the form of a commemorative medallion for $10 each. According to the Marine Habitats, Inc. of St. Augustine, Florida payment of the debt is well ahead of

schedule as the number of visitors to the *Spiegel Grove* has exceeded expectation (Maher, 2004).

Post-Deployment Evaluation

The *Spiegel Grove* was deployed to help protect the existing natural reefs and to provide an economic stimulus to the community of Key Largo. In order to determine if the ship could accomplish the goals, the Special Projects Office of the NOAA contracted with Marine Habitats, Inc. in July 2001 to gather the data required for testing the two hypotheses. The data have not been completely analyzed but the following discussion illustrates some of the processes being used to evaluate the project.

Data Analysis

In order to examine if diver usage patterns were altered, daily log book records were collected from cooperating dive charter operators for three distinct periods: Historical (August 2000 to July 2001); Pre-deployment (August 2001 to May 2002) and Post-deployment (July 2002 to July 2003). These data sets were also used to determine the economic returns from the private charter boat sector.

To calculate the total financial returns to the economy of Key Largo, an additional data set from the public (recreational) sector was required. A total of 160 days of on-water surveys at five natural and five artificial reef sites adjacent to the *Spiegel Grove* location were completed from August 2001 through July 2003. Survey dates were randomly selected between reef locations, weekday and weekend dates to capture as much variability in this sector as possible. Data such as time on-site, activity type (fish,

dive, or snorkel), and vessel size were collected on all vessels within and adjacent to the surveyed reefs.

Results and Discussion

Based on preliminary analyses of the dive charter operator logbook data, a small increase in diving activity occurred during the first ten months following the ship sinking.

Table 2 Pre- and Post-deployment Charter Boat SCUBA Diving Use

August to May 2002			**August to May 2003**		
Reef Type	**No. of Divers**	**%**	**Reef Type**	**No. of Divers**	**%**
Artificial	36,662	26.6	Artificial	46,146	33.1
Natural	101,315	73.4	Natural	93,132	66.9
Total	137,977	100	Total	139,278	100
Spiegel Grove only			**18,662**		**13.4**

During the study period, over 25,000 daily records of dive charter log book data was collected. This dataset represents the largest collection of economic use data ever obtained in a socio-economic study. Analyses of the specific reef sites that experienced declines in use following the deployment of the ship is underway, as well as calculation of the total economic return to the economy of Key Largo from both the private (charter boat) and public (recreational) use of the natural and artificial reefs are currently being conducted. The preliminary results from the dive charter operator data indicate that the hypothesis of introducing a preferred type of artificial reef in a natural reef environment reduces user pressure on the surrounding natural reefs is supported.

Although only a very small increase (1%) in total SCUBA diving use was identified during identical 10-month periods pre and post-deployment, many smaller (less than 6 passenger) charter boat operators indicated that they would have gone out of business in early 2003 if demand for trips to the *Spiegel Grove* hadn't existed. Even though the total activity was only slightly larger during the post-deployment period, almost 10,000 more divers used artificial reefs after the ships' sinking. This result occurred due to the presence of the *Spiegel Grove* and the proximity of adjacent artificial reefs such as the wrecks of the *Benwood* and the *City of Washington* (Key Largo Chamber of Commerce Artificial Reef Committee, 1997).

Figure 12 USS Benwood. Retrieved on 2/23/05 at http://oceandivers.com/photos/wrecks.

Figure 13 USS Benwood. Retrieved on 2/23/05 at http://oceandivers.com/photos/wrecks.

These data indicate that 13.4 % of the total charter operator diving use post-deployment took place on the newly created artificial reef of the ship. One of the most enlightening results was that 40.4 % of the total diving use on artificial reefs (18,662 dives) during the ten-month period following the deployment of the ship took place on the *Spiegel Grove*.

The increase in diving use on artificial reefs by design caused a 6.5 % decrease in use on the natural reefs by the charter dive operators during the ten-month period following the ship sinking. Therefore, a total of 8,183 less dives were made on natural reefs in this period, or approximately 800 fewer dives on a monthly basis.

These trends are also reflected in the data for the entire first year of use following the placement of the ship, which included the peak usage months of June and July (Table

Two). Within the ten-month period a total of 139,278 charter operator dives took place on all reef types (46,146 on artificial reefs and 93,132 on natural reefs). In comparison, when the peak usage months of June and July are included, total charter operator dive use consisted of 173,887 dives (52,290 on artificial reefs and 121,597 on natural reefs).

Table 3 Full Year Post-deployment Charter Boats SCUBA Use

August 2002 through July 2003				
Reef Type	**No. of Divers**	**%**	**No. of Snorklers**	**%**
Artificial	52,290	30.1	10,256	33.5
Natural	121,597	69.9	20,324	66.5
Total	173,887	100	30,580	100
Spiegel Grove	23,596	13.6	308	1.0
(45.1% of AR Use)				

Although the percentages of use between natural and artificial reefs did not change significantly from the ten-month period to the twelve-month post-deployment period, it is interesting to note that within the first year over 23,500 dives were made on the *Spiegel Grove*, which represented almost 50% of the total number of dives made on all artificial reefs offshore of Key Largo.

The full year data also indicate the importance of the peak months of June and July to the charter dive operators. These two months alone account for approximately 25 % of the annual charter operator dive business in Key Largo. When data from the twelve-month post-deployment on-water surveys are examined, the changes as a result of the two months of June and July were substantial, reflecting the higher use by both the private charter boat sector and the public recreational sector during these months as well. A total

of 561 persons were observed fishing, with 60 % of these use being conducted on artificial reefs. A similar trend for diving activities existed with 58 % of the private diving use occurring on the artificial reef sites observed.

The data regarding the private fishing and diving use of the reefs still remains to be completely analyzed, but preliminary results provide insights into these use sectors.

Table 4 Post-deployment Public (Recreational) Use on Reef Sites August 2002 to May 2003 (Ten Month Period)

Reef Type	**No. of Anglers**	**% of Total Use**	**No. of Divers**	**% of Total Use**	
Natural	720	70.6	297	55.3	
Artificial	300	29.4	240	44.7	
Total	1,020	100	537		
% of A/R Use					**% A/R Use**
Spiegel Grove Only	39	3.8	136	25.3	**56.7**

Spiegel Grove % of A/R Use - 13.0

Table 5 August 2002 to July 2003 (Twelve Month Period)

Reef Type	**No. of Anglers**	**% of Total Use**	**No. of Divers**	**% of Total Use**	
Natural	885	69.0	419	58.7	
Artificial	397	30.1	295	41.3	
Total	1,282	100	714	100	
% of A/R Use					**% A/R Use**
Spiegel Grove Only	65	5.1	178	24.9	**60.3**

Spiegel Grove % of AR Use – 16.4

Both the ten and twelve month data indicate that public (recreational) sector diving use following the ship's deployment was somewhat higher on natural reefs compared to artificial reefs. These public sector data are very similar to the data recorded

for the private charter boat sector. However, the *USS Spiegel Grove* accounted for approximately 25% of total public diving use during both the ten- and twelve-month periods. Table 4 also illustrates that over 60% of all observed public diving use that took place on the observed artificial reef sites took place on the newly deployed ship itself; as compared to 45% of all artificial reef charter boat diving use.

These preliminary results provide some insight as to the effect of intentionally placing a highly preferred type of diving reef (a large ship) in a region with the highest level of charter-based and private diving activities in the United States. Further in-depth analyses of the amount of private use estimated from the on-water observations described above, combined with economic multiplier effects for both the private and charter sectors will allow an extremely accurate estimate of the total economic contribution of the *Spiegel Grove* to the economy of Key Largo.

Method Analysis

Documentation for the *Spiegel Grove* is more extensive then that of the *Yukon*. NOAA is conducting post-deployment measurements to evaluate the project in order to determine if the ship is accomplishing its environmental and socioeconomic goals. Below is a preliminary analysis of the method; this evaluation is in the development stage and the final report has not yet been published.

Preliminary Analysis of the Spiegel Grove Post-Deployment Evaluation

The first step was to determine diver use patterns and compare the pre and post deployment data to identify any modification in the use. Daily log book records were collected and historical data was recorded.

The second step was to calculate the financial returns to Key Largo using the data from NOAA. The method included the completion of 160 days of on-water surveys at five natural and five artificial reefs that are adjacent to the *Spiegel Grove* from August 2001 through July 2003.

Results and Discussion

Once the records have been analyzed it will represent the most current collection of economic reef-use and provide some empirical data to the biological impacts of artificial reefs. The preliminary fish counts indicate new stocks identified on the structure and an improvement of the existing natural reefs (Maher, 2004). Although the preliminary study focused on a ten month period it did cover a representative period of peak and non-peak use. The increases in use need to be analyzed closer to account for collateral reasons for the increases in use; however the fish counts and reef health observations are encouraging.

Although the percentages of use between natural and artificial reefs did not change significantly from the ten month period to the twelve month post-deployment period, it is interesting to note that within the first year over 23,500 dives were made on the *Spiegel Grove*, which represented almost 50% of the total number of dives made on all artificial reefs offshore of Key Largo (*Ibid*).

In sum, a well established decision-making method with clear criteria could have relieved many of the economic burdens experienced by the project's developers. In addition, it would have provided Monroe County and other government stakeholders an ability to establish regulations consistent with the goals of the project. These preliminary

results provide some insight for establishing a decision-making method for considering the implications of an additional artificial reef in a region with the highest level of charter-based and private diving activities in the United States.

The *USS VANDENBERG*

Figure 14 USS Vandenberg. Retrieved on 2/23/05 at http://www.bigshipwrecks.com/diving/James%20River%20pages/111.htm

The *Vandenberg* project is the first artificial reef proposal to address multiple market and non-market uses. This project is an entrepreneurial effort designed to address multiple needs of a locality, Key West, Florida. REEFMAKERS, Inc. is a Pennsylvania Corporation established to provide services to coastal communities in the United States to enable them to develop artificial reefs to further the economic, environmental and educational quality of their areas. REEFMAKERS is working closely with the non-profit

corporation Artificial Reefs of the Florida Keys (ARK) in establishing partnerships with all relevant local, state and federal agencies, the local business community, international diving organizations, environmentalists, and educators. ARK and REEFMAKERS have secured the ship, completed site selection and obtained required permits. The primary goal of the *Vandenberg* project is the successful establishment as an artificial reef and provides a replicable, economically viable model for recycling obsolete ships such as the MARAD vessels by partnering with private/public entities to deploy them as artificial reefs. Current estimates by REEFMAKERS indicate that several hundred large ships could be sited in United States waters alone (REEFMAKERS, 2004).

Socioeconomic Impact

The Business Plan of the *Vandenberg* proposed the project understanding the need to demonstrate the socioeconomic impacts such a project could have. The discussion is separated into two parts; economic and socio.

Economics

REEFMAKERS estimates that the average contract fee per ship will be $2,200,000. REEFMAKERS will work with the host community to secure funds to off set their fees by actively marketing the project to maximize new recreational spending in the community. REEFMAKERS additional revenue sources will include payments from the agency seeking to dispose of the ship, recycling revenue from the sale of items removed from the ship, commercial media contracts, naming rights and sponsorships, sale of advertising and educational, research and economic development grants.

At over 520 feet and 13,000 tons the *Vandenberg* will be among the largest ships ever intentionally sunk for this purpose. The ship should become a world-class diving and fishing destination. The project has the potential for unprecedented programs in the fields of environmental monitoring, education and historical preservation with partnerships and collaborations already underway. For example, the Florida Keys Community College has partnered with REEFMAKERS to develop academic uses for courses. Other educational institutions are available to partner for similar projects. As with Indiana University and the *Spiegel Grove*, the opportunity for education and research is a use that goes beyond the traditional recreation uses (Indiana University, 2005). These non-market uses can provide decision-makers with additional values to consider when evaluating an artificial reef project.

REEFMAKERS has also received funding and support from other non-traditional sources; some examples are as follows: The *Vandenberg* project has received a $250,000 matching grant from the Monroe County Tourism Development Council for the project. To date, approximately $150,000 in matching funds has been pledged from NOAA, the Florida Fish and Wildlife Conservation Commission. Local dive shops, Jimmy Buffets' Singing for Change Foundation, PADI (Professional Association of Diving Instructors), the world's largest SCUBA diving professional certification agency and Drager Safety have contributed and agreed to feature the project in their literature and websites. Through the Florida Fish and Wildlife Conservation Commission (FWC), and on behalf of ARK, REEFMAKERS is pursuing a grant of $ 1,250,000 from MARAD to accompany the vessel transfer. REEFMAKERS has developed an aggressive marketing

strategy to sell naming rights and sponsorships for each reef, individual rooms and "dives" on each ship and memorabilia from the ships.

Socio

Despite the existing data on the economic and recreational benefits of artificial reefs, their full potential remains unrealized. Willingness-to-pay surveys conducted in the four Florida counties presented in the Hazen & Sawyer Report indicated that visitors to the Florida Keys were willing to spend an additional $21 on licenses to support the artificial reefs. But what if the survey included uses other than recreational, would the responses have been the same? For example, if the survey asked for willingness-to-pay for an artificial reef project if it included with recreation, educational, research, and conservation? Residents of the Florida Keys may also have elevated levels of willingness-to-pay if they were to realize the benefits.

What about non-market uses? Non-use values may provide a significant response if the survey was to include questions with stewardship, posterity, or preservation as part of the contribution or willingness-to-pay. To use the existing studies' method for decision-making without including other market and non-market uses severely limits the decision-makers scope of understanding of the project's impact.

Educational/Research Partnerships

NOAA, as well as other agencies support and have funded the *Vandenberg* project. Experience in Key West by the projects' founder has enabled the project to structure programs that take advantage of the unique resources of each host community, reef location and ship history. For example, Stevens Institute of Technology will partner

with the Florida Keys Community College (FKCC) and the REEF (Reef Environmental Education Foundation) to develop and maximize the research and educational uses of the *Vandenberg* as an artificial reef. Other possible partners include the Mote Marine Laboratory, the Nature Conservancy, the Florida Keys Turtle Hospital, University of North Carolina Wilmington and the Florida Marine Research Institute (REEFMAKERS, 2004).

Debt Recovery Strategies

Debt recovery was discussed briefly above; more detail in the innovative methods used by REEFMAKERS is worth discussing here. Decision-makers may want to know the level of commercialism a project may promote, or the ability to repay loans, etc. Besides traditional means of debt recovery (i.e. grants, loans, contributions), REEFMAKERS has developed other mechanisms to repay the debt incurred from the project. These techniques a combination of user fee and marketing scheme and included the following.

Dive Sponsorships: The *Vandenberg* will offer seven different designated areas of the wreck (e.g. "today we're diving the Subway Chapter – the Subway restaurant."). Sponsors will be invited to have logos or slogans welded in their Chapter providing permanent recognition. This strategy has worked well on ski runs across the country. Dives will be marketed at $100,000 each for a lifetime sponsorship.

Room Sponsorships: There will be over 50 rooms large enough for divers to visit on the Vandenberg. Logos, symbols or memorabilia that are of significance to sponsors can be

affixed in these rooms. Room sponsorships will be offered for up to $50,000 for the largest areas. Jimmy Buffet's fan clubs have teamed to buy a room sponsorship.

Plaque Sponsorships: Three different sized environmentally friendly plaques will be offered at $1,500, $5,000 and $10,000 each to be welded in to various rooms in the reef. Plaques will be plate steel stencil cutouts which eliminates the need to rub off marine growth allowing the sponsor's name to remain readable as the plaque forms its own little ecosystem. Many have been sold and fundraising efforts are fully underway.

Memento Sponsorships: Various high quality items will be removed from the ship and restored for purchasers. Three types of items from the *Vandenberg* have been identified for this purpose. Porthole sponsors (at $15,000) will receive a rare, sequentially numbered porthole that has been cleaned, restored and mounted on hardwood with the sponsor's name engraved on a numbered plaques. Lamp sponsors (at $1,000) receive a restored brass cage lamp mounted on hardwood that can be wired for actually use. Switch sponsors (at $500) receive a hardwood mounted brass switch used in ship operations.

Method Analysis

The methods applied in the NOAA Study used the premise that the baseline economic status of the reef system would represent both demand and supply. It is necessary to establish both when evaluating natural resources as policy issues. The supply side would indicate how many artificial reefs were accessible or how many acres of natural reefs were available to users. The demand side would address how many

persons per day were using the reef. Together they help identify the carrying capacity – how many users are too many.

The concept used in evaluating the economic benefit is "use value", a resource that is "used" by consumers and not paid for by them directly. This is appropriate for a "common property" such as a reef. The use value is measured with the willingness to pay model – the willingness of users to pay (the value) to use the natural resource. The most significant statistical relationship in this model was the amount willing to be paid and the income of the respondents - the higher the income the more the respondent was willing to pay to support a new artificial reef. As discussed, this is only a reflection of recreational uses and does not adequately reflect to full scope of the potential market and non-market uses and values.

Economic Impact

An artificial reef project may be thought of in terms of spending when considering the economic impact on a county. However, it is what this spending does that is more important. The NOAA Study stated that the reef industry generated wages for Monroe County of $19.1 million (2001 dollars). According to the U.S. Department of Commerce, Bureau of Economic Analysis (non-farm earnings), reef-related activities provided $233.8 million in wages, 16.1% the total employment for the county. Therefore, the failure to protect the reef resources could, at the margin, create a catastrophic economic failure affecting the diversity of businesses from dive shops to real estate.

Accepting the premise that, all other things being equal, the only variable that would affect use among resident users is an increase in the resident population because of crowding of the site. And that population is increasing according to the Florida Statistical Abstract for 2001. The existing carrying capacity of reef system has already been exceeded according to the NOAA Study (2003) and the forecast of increased population and visitor use demands that attention be given to alternatives to existing use sites. Visitor demand tends to be more volatile to the socioeconomic health, and because of the magnitude of visitation to the Florida Keys the economic impact is more dramatic (NOAA, 2003). Tourism and reef use support businesses (i.e. hotels, dive shops, etc.) impact the local economy on a greater scale, considered together, declines in both resident and visitor use could damage the socioeconomic health of the Florida Keys for years to come. Therefore, since natural reefs cannot be developed in a short period of time, artificial reefs are the most effective method of addressing diminished carrying capacity and ensuring the economic stability and growth.

Monroe County's annual reef-use value (2001 dollars) was $9.75 million. With the projected growth of the reef-use industry in the Florida Keys, additional artificial reef projects can provide an economic and environmental benefit. Government management is necessary to ensure the longevity of the reef-system and protect the health, safety, and welfare of the citizens of the county. The NOAA Study stated that for every dollar spent on the management, the county generates about $23 in use value flowing from the reef users; that equates to annual net revenues of approximately $245 million (2001 dollars).

Monitoring

Monitoring the reefs and the user value cannot be underestimated. It is paramount to be aware of any changes that could affect the need for additional artificial reefs. Overall health and carrying capacity must be forecasted and current status evaluated to provide for the incremental project process. With existing requirements the permitting and deployment processes take longer than deterioration of a reef. If the trend is not reversed, the negative impact of a deteriorating reef system could create a decline in the economic health of a locality for a long time. A reef monitoring program should be part of the artificial reef project's plan to ensure continued environmental and socioeconomic stability and growth.

The Hazen/Sawyer Report & NOAA Study

The data were collected by Hazen & Sawyer Inc., through survey respondents that consisted of both visitors to the Florida Keys and those who live in the Florida Keys (visitors and residents). The Hazen & Sawyer Report was then given to NOAA whose staff ran the analysis and provided the conclusions and produced the study. The results most significant to this discussion are those for the category "New" artificial reefs, which will be the focus of this discourse. Although the data collection was done through the Hazen & Sawyer Report, it is the NOAA Study that produced the conclusions referenced in the artificial reef projects discussed here.

Assumptions

The NOAA Study method used supply and demand to determine carrying capacity of the reef system – number of users (demand) and number of locations (supply).

To determine the use value the NOAA Study method implemented the willingness to pay model which asked how much a user would be willing to pay in an increased costs for a new artificial reef. The relationship between income and the willingness to pay demonstrated a positive correlation; the higher the income, the higher the value. The level of measurement in the method is defined below:

"Level of Measurement" is the units that represent recreational activity labeled the "person-trip" and the "person-day". The person-trip represents one person making one trip to Monroe County. The trip could last one day or several days. For resident boaters, a person-trip is one day's outing on a boat to participate in the activity. A person-day represents one person participating in an activity for a portion or all of the day.

Method

The NOAA Study used survey research from June 2000 to May 2001 (for example approximately 3,500 were mailed to registered boaters in Monroe County with 790 responses, about 22%) to measure economic contribution and the use values of both artificial and natural reefs. In addition, intercept surveys were conducted for recreational visitor users (3,855) and visitor boaters (2,473) from the summer of 2000 and winter of 2001.

To determine use value the study used the contingent valuation (CV) method to identify their willingness-to-pay for a reef system, contingent on specified conditions (e.g., use of funds for various reef related improvements). This included the support of an additional artificial reef. A Logit model was used to estimate use values per party per trip. The model tested for differences by activity, household income, age of respondent, years of boating experience in Monroe, race/ethnicity, sex, length of boat owned, and whether a member of a fishing or diving club.

The Logit model estimates for "new artificial reef program" found significant differences in willingness-to-pay. Snorkelers and scuba divers on artificial reefs had higher values than those who participated in fishing activities. The other significant difference was household income; as income increased so did willingness-to-pay.

Conclusion

The NOAA Study concludes that the willingness-to-pay anything for expansion of the reef system demonstrates some level of unhappiness with the existing number of artificial reefs off the Monroe County coast. Using a survey that relates a use value to respondent income is incomplete. Decision-makers must have a rich understanding of user values only achieved by using a tool that includes all potential market and non-market uses. To conclude that users are only willing to pay for an active use is incomplete. Users may wish to protect the resource for future use, or for other non-use values.

The existing artificial reef projects discussed in this Chapter illustrates the lack of comprehensive planning and the problems encountered because of it. Decision-makers

obligated large amounts of tax-payer monies to a project with anecdotal evidence that they would be reimbursed. In addition, the existing studies were incomplete in their assessments. Only addressing recreation uses fall far short of the potential uses, and therefore the potential values of new artificial reef projects. An established decision-making process such as the one proposed in this dissertation would provide continuity in review of a future artificial reef, and other natural resource projects.

Chapter 7
A DECISION MAKING MODEL

Monroe County's Decision-Making Foundation

Monroe County's decision-making responds to the directives given by the State of Florida through the designation as an Area of Critical State Concern (ACSC). This designation led to the development of the Florida Keys Carrying Capacity Study (FKCCS) that evaluated the county's ability for future development with respect to the environmental concerns and the hurricane evacuation requirements. Below is a brief description of these two enabling legislations that are the foundation of the Monroe County Board of County Commissioners (BOCC).

Areas of Critical State Concern

Established in Chapter 380.05, Florida Statutes, the ACSC program protects resources and public facilities of major statewide significance. The Florida Department of Community Affairs (DCA) staff reviews all local development projects within the designated areas and may appeal to the Administration Commission any local development orders that are inconsistent with state guidelines. The Division also is responsible for reviewing and approving amendments to comprehensive plans and land development regulations proposed by local governments within the designated areas.

Work Program Timeline

• April 1993 - Monroe County adopted its plan to meet the requirements of the growth management act.
• 1993 - The Plan was found not in compliance by DCA.
• October 1994 - An administrative hearing was conducted to determine the validity of the Department's approval and rejection rules and as well as proposed Rule 28-20.100 Florida Administrative Code (FAC).

• December 12, 1995 - The Administrative Commission entered a final order, finding the plan not in compliance, noticing a proposed rule and ordering facilitated rulemaking/mediation to address outstanding issues.
• January 1996 - Ninety percent of the Plan became effective. Disputed provisions of the rule required further action.
• Mediation was conducted resulting in subsequent rule changes. The amended rule introduced the Five Year Work Program.
• Rule changes were again challenged. At this point in time Monroe County intervened in alignment with the Administration Commission.
• August, 1996 to December 1996 - An administrative hearing was held. The proposed rule was upheld by final order and the Administration Commission adopted Rule 28-20.100 in July, 1997.
• Annual reports related to the implementation of the Work Program are required to be submitted to the Governor and Cabinet. Lack of substantial progress would result in a loss of the 20% of annual allocation of permits originally established at 255 permits per year.
• November 1997 - This final order was appealed, oral arguments were heard and the First District Court of Appeal's affirmed the Final Order in December, 1997. (Monroe County, 2003)
• December 1997 - The Village of Islamorada incorporates and begins working on its comprehensive plan. Its initial allocation is set at 28 permits.
• March 1998 - The first report to the Governor and Cabinet is issued. The DCA finds that substantial progress has been achieved.
• January 1999 - The second report to the Governor and Cabinet is issued. It documents a lack of substantial compliance and recommends a 20% reduction in available permits. It also identifies lack of progress in cesspit identification and removal and recommends that the Five Year Work Program be revised to incorporate changes related to this program.
• July 1999 - Rule 28.28-100 is amended to implement the above-mentioned recommendations.
• November 1999 - The City of Marathon incorporates. Marathon is allocated 24 permits (reflecting the 20% reduction) and Rule 28-18 is adopted.
• May 2001 - DCA submits its Year Three Assessment Report. The Department finds that substantial progress has been made and recommends that the Governor and Cabinet restore the permits that were taken away in 1999.
• The Governor and Cabinet initiate rule making to restore permits and the proposed rule is challenged.
• January 2001 - Islamorada adopts its comprehensive plan. The plan is found not in compliance. After a second set of remedial amendments the plan is found in compliance in September 2001.
• August 2002 - DCA submits a revised rule based upon negotiations by affected parties. DCA recommends that permit restorations be deleted based upon the likely determinations that adequate progress was not made in year four and five of the work program. In 2002, the Governor and Cabinet adopt the revised rule which eliminates the restoration of permits. The current annual allocation is as follows:

Monroe County 158
City of Marathon 24
City of Islamorada 14 (voluntarily reduced from 22)

• November 2003 - DCA submits a comprehensive summary of the Florida Keys ACSC Program since 1993 and an assessment of work program compliance by Monroe County, Marathon and Islamorada.

Habitat Protection

• 1986 – Monroe County Comprehensive Plan is adopted. Large undeveloped tracts are designated "NA" for Native. The overall developed density of the Florida Keys is significantly reduced

• 1997 – The Five Year Work Program contains several important items related to habitat protection such as the development and implementation of a master land acquisition plan aimed at preserving habitat (a collaborative process to adopt plans/regulation to protect terrestrial habitat)

• The DEP has three large Conservation and Recreation Lands (CARL) areas in the Florida Keys – Coupon Bight, North Key Largo Hammocks and Florida Keys ecosystems – and several other acquisition areas. By 2003, the DEP has acquired 9,088 acres at a cost of $152.4 million.

• Monroe County establishes the Monroe County Land Authority in 1986. By 2003 it has acquired 1946 acres at a cost of $46.9 million. The Florida Community Trust provided $22.9 million to Monroe County over the past ten years to assist with these acquisitions.

• 2002-2003 – Monroe County adopts a policy framework for habitat protection by adoption Goal 105 which provides a basis for three land use tiers. In August 2003, Monroe County designates conservation and natural areas for acquisition. The estimated parcels designated for acquisition within Monroe County as follows: 8,548 acres with an assessed valuation of $42.9 million. The estimated acquisition cost is $130 - $150 million.

• 2003 – Monroe County completes and submits the Habitat Conservation Plan for Big Pine Key to the U.S. Fish and Wildlife Services. The Plan allows for only 200 more residential units to be constructed on Big Pine Key.

• 2002-2003 – A collaborative process to assist in the implementation of the Florida Keys Carrying Capacity Study is initiated and completed. This work group recommends that sensitive habitat be protected from encroachment through use of additional land acquisition funding sources.

*Amendments adopted in 2002

The Florida Keys Carrying Capacity Study

To view population growth in the Florida Keys in its entirety, the designation of the Florida Keys as an Area of Critical State Concern must be considered. The Florida Keys received this designation from the State of Florida in 1975 due to the environmental sensitivity of the area and the extraordinary development pressures looming on its horizon. The comprehensive planning process that Monroe County has undertaken since being designated as a critical area has resulted in the Rate of Growth Ordinance (ROGO) and other efforts to manage the constant growth pressures affecting this area. The conception of the Florida Keys Carrying Capacity Study, the associated development of Rule 28-20, Florida Administrative Code, F.A.C., its subsequent legal challenges and ultimate adoption, gives perspective to how and why the decision-making method works in Monroe County.

The adoption of the current 2010 Monroe County Comprehensive Plan took seven years. After several years of legal challenges, it was finally adopted in April of 1993, but subsequent legal proceedings prompted a Final Order and Recommendations by a hearing officer in 1995. The goal of the FKCCS, excerpted from Rule 28-20.100, F.A.C. was as follows:

"*The carrying capacity analysis shall be designed to determine the ability of the Florida Keys ecosystem and the various segments thereof, to withstand all impacts of additional land development activities."*

The FKCCS was started in 1999 with a series of technical workshops to refine the scope of work and was jointly funded by the Florida Department of Community Affairs and ACOE. Six million dollars was allocated to produce the Monroe County Sanitary Wastewater Master Plan, the Stormwater Management Plan and the FKCCS. The contractor, URS Corporation, completed the FKCCS and the Carrying Capacity/Impact Assessment Model (CCIAM) in 2003 (Monroe County, 2003), a separate component to be used in forecasting land use scenarios. The findings of the FKCCS state, among other things, that "Development in the Florida Keys has surpassed the capacity of upland habitats to withstand further development."

DCA, in partnership with the Corps of Engineers and Monroe County, initiated the FKCCS and developed the Carrying Capacity Impact/Analysis Assessment Model (CCIAM) and the Routine Planning Tool (RPT). The CCIAM and RPT were developed to help evaluate the impacts of additional development in the Florida Keys and to plan the future of Monroe County.

The National Research Council of the National Academy of Sciences reviewed the CCIAM and FKCCS and, as a result of their review, adjustments were made to the CCIAM. The Council's review concluded that overall, due to data constraints and other issues in certain portions of the CCIAM, the model proved insufficient to develop a comprehensive carrying capacity framework that would allow for undisputable determinations of whether future development scenarios fall within the carrying capacity of the Florida Keys. The marine module, the most data deficient module, was subsequently removed from the CCIAM. As better data become available, this module

may prove to be significantly useful in establishing a quantitative, predictive relationship between land use, development and impacts to water quality. Reviewers agreed however, that the *terrestrial portion* of the CCIAM was able to provide valid analyses and conclusions with respect to upland habitat. Science can forecast from previous data what the impacts of a trend would be into the future should things continue as they currently are and historically have been. The accuracy of the prediction depends on the accuracy of the data and the ability to link relationships between factors. In some portions of the model, either data or relationships were inadequate to form conclusions about outcome. Some model predictions, however, based on the terrestrial module were shown as conclusive. Planners, politicians and administrators and stakeholders can now work together to implement recommendations.

With respect to terrestrial, upland habitat, the Monroe County FKCCS (2003) indicated that fragmentation of habitat is a primary concern citing research that indicated, "Small patches of forest show lower biodiversity, increased vulnerability to invasion by exotic plant and animal species and decreased gene flow within and among populations." In addition, the FKCCS also indicated that, "The secondary and indirect impacts of development further contribute to habitat loss and fragmentation." The conclusion is drawn by the FKCCS that, "*Any further development in the Florida Keys would exacerbate secondary and indirect impacts to remaining habitat.*"

Florida Keys Carrying Capacity Study Update

Mr. Ricardo Calvo, Program Director of Natural Resources for URS Corporation and developer of the FKCC study and model presented the latest update for both on

September 15, 2003. His presentation concentrated particularly on the "Smart Growth" scenario. Among his observations, was that there are scientific data demonstrating upland habitat has already been so compromised that it cannot withstand additional development. He made the point that the Carrying Capacity Model does not yield a specific number that should be allowed for additional development; rather it is the location of the development that is critical. He cautioned that Monroe County should be careful about basing recommendations on the Study if it is not able to support them and he was concerned about basing an ultimate number on anything other than the hurricane evacuation model.

The Florida Keys continues to experience residential growth and increased tourism with the expectation that the growth trend is going to continue limited only by the carrying capacity of the islands. The dominant industry of the Florida Keys is tourism and the primary attraction is the reef system; the natural and artificial resource supports a variety of uses from recreational fishing and scuba diving to the ancillary businesses that support the tourism industry such as hotels and restaurants (University of Florida, Bureau of Economic and Business Research, Florida Statistical Abstract, 2001, 2002). Given this socioeconomic dependence, it is in the best interest of government to protect and support the resource. One way to protect the reef system is to alleviate the pressure on the reefs, either by restricting their use or by providing substitutes to their use. Since the use of the reef is of primary importance to the residents and businesses of the Florida Keys' community, restricting the use of the reefs is not a practical alternative.

Therefore, providing substitutes (e.g. new artificial reefs) is a more logical alternative for decision makers.

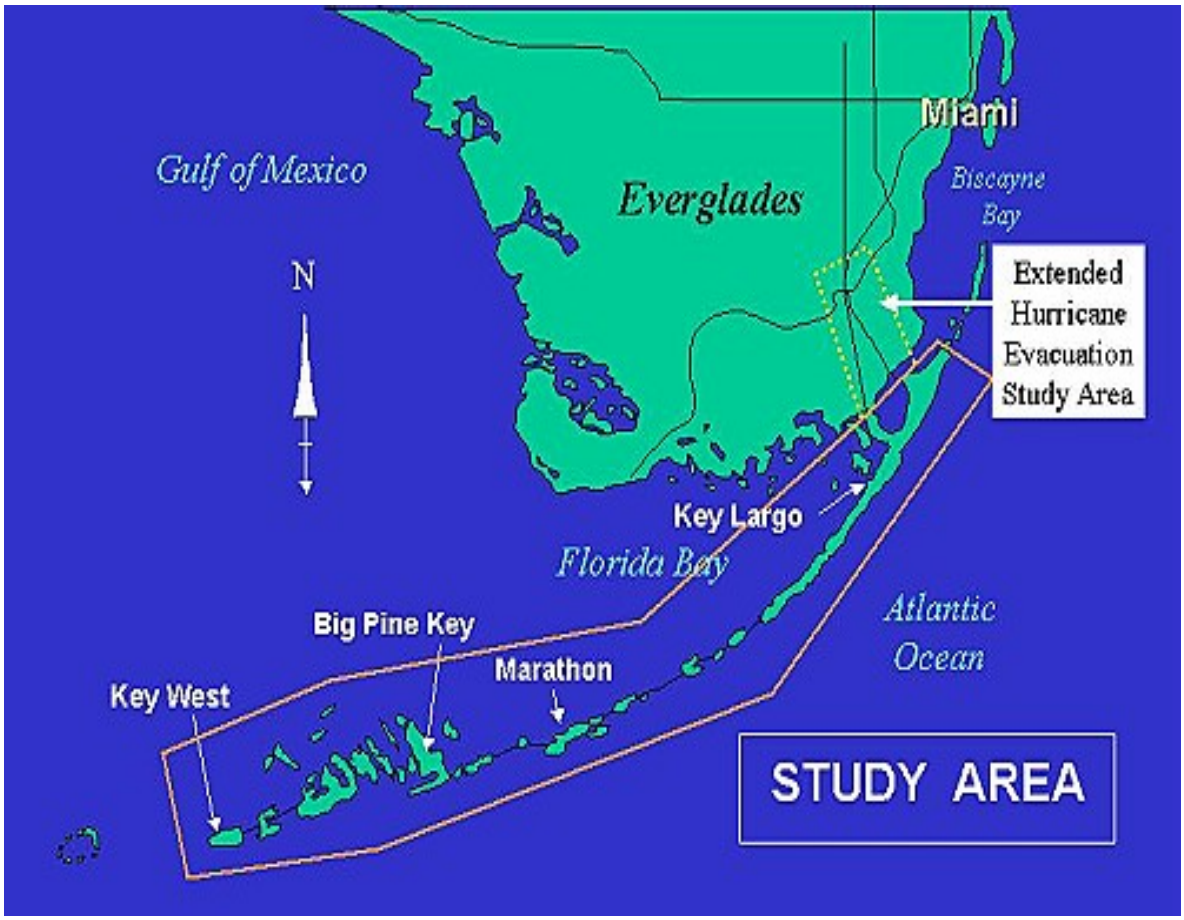

Figure 15 Map of Monroe County Florida Keys Carrying Capacity Study 2003

Florida Keys Carrying Capacity Study Timeline

• 1996 - Five Year Work Program requires the development of a carrying capacity analysis study completed by July 2002.
• 1996 – The US Army Corps of Engineers and the DCA form a partnership to jointly fund and complete the study. A scope of work is drafted, reviewed and completed. The technical contractor is hired and work begins on the Carrying Capacity Impact Analysis Model (CCIAM) and the study. The draft final report is issued in 2001.
• 2001 – The draft report is completed and peer reviewed by the National Research Council. In April 2002, the Council determines that the CCIAM is not ready to determine the ability of the Florida Keys ecosystem to withstand all impacts of additional development activities as required by Rule 28-20.100.

• 2002 – The Carrying Capacity Study and model are revised based upon the initial peer review. A second peer review is conducted and it is determined that the CCIAM may be a useful tool but it has substantial limitations. In particular, the CCIAM is unable to determine the impact on near shore water quality. This peer review committee agrees in the following four recommendation of the study:
1. Prevent encroachment into native habitat because of severe depletion by historic development activities:
2. Continue restoration and land acquisition programs, implement the wastewater and storm water master plans, and continue ongoing research and management activities in the FKNMS;
3. Concentrate on redevelopment and infill for future development; and
4. Increase efforts to manage remaining habitats and resources.
• November 2002 – The DCA initiates a Florida Keys Carrying Capacity/Rule 28.20

Decision-Making and Artificial Reefs

The ACSC and FKCCS provide Monroe County's governing legislation with regards to environmental decision-making. The legislation is the foundation of the county's policy directive, the Comprehensive Plan. However, as discussed by the FKCCS update, the carrying capacity in respect to development has been exceeded and compromised to the point where it may be unsustainable. In response, Monroe County has taken steps to reduce development and protect natural resources. The HCP is an example central to Key deer habitat. Other development/redevelopment policies and regulation are in the political cycle. But how does Monroe County address the sustainability issues of the reefs? NOAA has stated in their study that the Florida Keys reef system has exceeded its carrying capacity based on recreational use. Two artificial reefs have been approved and one deployed. How were these projects submitted and reviewed? What were the decision-making process's strengths and weaknesses? The following discussion looks at the *USS Spiegel Grove* and the *USS Vandenberg* artificial

reef projects and compares their proposal projects and the decision-making process used in their review and approval.

Sinking the Dream

Artificial reef projects usually begin as an entrepreneur's dream to create an underwater habitat, hopefully to include environmental enhancement along with a profit. Assuming that the considerations mentioned previously have been addressed and the site research has been done, it is time for the dream to begin its journey to fruition. The first stop on the journey should be the local government or other authorized sponsor such as the County. Without sponsorship the ACOE will not issue a permit, so sponsorship is critical. For the *Spiegel Grove*, that sponsorship was Monroe County and for the *Vandenberg*, sponsorship came from the City of Key West. How does the County review an artificial reef proposal and what is the decision-making process? In the interview with Mr. George Garrett, Director of Marine Resources for Monroe County it was apparent that empirical or scientific data are not a determining factor in the decision-making process. As with most decisions made by an elected body, politics heavily influences outcomes. For artificial reef projects the county follows a loose process and then makes a recommendation that is incorporated into the staff report presented to the BOCC. There are a series of public hearings with public input followed by discussion by the BOCC. This is a lengthy process that can take over a year to be finalized. The staff review follows the following procedure:

Evaluates the site location. This process includes discussions with other agencies and a review by the local branch of the Florida Keys National Marine Sanctuary (FKNMS).

Evaluates the socioeconomic impacts. Using the NOAA Study as guidance the proposal is evaluated using criteria identified in the NOAA Study, primarily TCM valuation and local area knowledge. This subjective process is followed by an assignment of a weighted score, typically a 3 on a likert scale 1-5.

Evaluates the non-market values. Although there is no formal method used to evaluate non-market/non-use values, the interviews revealed that decision-makers do not evaluate qualitative values such as aesthetics, stewardship, and conservation perpetuity. This score is averaged in with the previous score and given a generic evaluation and delivered to the BOCC in the staff report which contains a narrative and analysis of the proposal.

Monroe County relies heavily on the comments from the FKNMS Superintendent. Although a proposal that would be deployed within the boundaries of the FKNMS would need a permit issued to them from FKNMS, the system of evaluation follows the NOAA Study guidelines and does not look beyond the recreational values and emphasizes the health of the FKNMS.

The NOAA Study Comparison

As part of the NOAA Study a survey was conducted of policy makers responsible for natural and artificial reefs in their particular counties. The purpose was to obtain an impression of the effectiveness of the Hazen & Sawyer Report from those recognizing the need from such a report. Monroe County felt that at least 50% of their time involved dealing with socioeconomic matters, but such matters fluctuated with the ebb and flow of public projects, damage to resources, and pressure from environmental groups to adopt various policies. All persons contacted had heard of the Hazen & Sawyer Report and

read at a minimum the Executive Summary and the chapter corresponding to their particular county.

The survey also identified that Monroe County understands the economic impacts of the reef system, yet has not dedicated any funding for the development of an artificial reef program. Understanding the positive relationship of the reef system to the economic health of the county based on the Hazen & Sawyer Report, policy should have been implemented to improve the health of the reefs. The data stated that the carrying capacity of the reef system had been exceeded and therefore a policy to improve the health of the reef system should be critical to both short-term and long-term planning, such as the development of a comprehensive artificial reef program (NOAA, 2003).

The *USS Spiegel Grove*

As discussed earlier, the *Spiegel Grove* was proposed by the local dive industry entrepreneurs with the primary objective for deploying the ship was to determine if scuba diving use on adjacent natural reef sites could be reduced through the placement of an artificial reef. The secondary objective was to stimulate the local economy of Key Largo through increased diving related tourism (Key Largo Chamber of Commerce Artificial Reef Committee, 1997). This was the first artificial reef proposal at the magnitude of the *Spiegel Grove* in size, cost, and potential impact. The proposal, after meeting the preliminary requirements of the FKNMS, Army Corps of Engineers and other agencies, was reviewed by Monroe County and submitted for approval consecutively with a request for funding. The proposal lacked any empirical data to support their conclusions; the proposal relied on the data of the NOAA Study for validation of the proposal and creative

debt recovery strategies described in their Business Plan. The narrow scope of use limited the projects scientific potential and was in need of a post-deployment data collection strategy. The decision-making process appeared to be primarily a political support issue with the intent to stimulate the economy of Key Largo and the Upper Florida Keys. However, the preliminary post-deployment data seems to support the projects hypothesis that the deployment of the artificial reef would relieve use pressure on the surrounding natural reefs and stimulate new population of reef fish (Maher, 2004). With the perceived success of the project, Monroe County appears to be content with their decision-making process. However, since the applicants of the *Spiegel Grove* used a primarily volunteer deployment workforce it encountered several significant problems resulting in delays and miscalculations in revenue needs. The problems of the *Spiegel Grove* are discussed in Chapter 2 and were not lost on Monroe County when the *Vandenberg* proposal sailed into their review.

The *USS Vandenberg*

The *USS Vandenberg* was proposed by an entrepreneur interested in creating an artificial reef with an expanded list of uses including scientific, educational, recreation and economic. This more comprehensive utilization of the project provides Monroe County with an expanded socioeconomic base that could include colleges/universities, the scientific community such as Mote Laboratories which has a field facility in the Lower Florida Keys, and unique economic opportunities for the community with creative marketing as described by the Business Plan. Again, the NOAA Study was used to validate the conclusions and projections of the project. In addition, the *Vandenberg* can

refer to the short-term success of the Spiegel Grove in Key Largo. The most significant difference in the proposal strategy for the *Vandenberg* was the use of professionals in the project development. From cleaning to sinking, the *Vandenberg* proposed to use experienced companies to avoid the costly mistakes of the *Spiegel Grove*. However, the improved project development could not shake the negative experiences of the *Spiegel Grove* and Monroe County refused to sponsor another artificial reef project until debt recovery and post-deployment data could be analyzed. Monroe County did agree to provide some badly needed funding for the project after the first year debt recovery data demonstrated that the *Spiegel Grove* was ahead of their projections.

Conclusion

The Monroe County decision-making method is primarily a political process with the significant influence coming from the business community and the FKNMS. Determining the desirability of an artificial reef project is accomplished by marketing and dubious business perspectives. If environmental decision-making is not required by state or federal mandates such as the changes in development and habitat protection initiated by the Florida ACSC legislation or the FKNMS use restrictions, then Monroe County does not seem to have a method in place to determine a project's desirability. If presented with a model to assist in the consideration of a projects short and long-term benefits and costs, perhaps future environmental decisions will look to the future instead of the past for determination criteria.

Building A Better Model

This dissertation demonstrates the need to identify alternate methods to provide decision-maker's the information necessary to make evaluations leading to the deployment of artificial reefs. The ramifications of a policy can extend far beyond the physical boundaries of the Florida Keys, as other regions will always look to the impact policy has had on the characteristics of this region when deliberating over an artificial reef project. Other projects around the world are following examples of the very few attempts in the United States at establishing methods for evaluating artificial reef projects. Justification other than "if you build it, they will come" must be established so that diligent consideration and precautions are taken to ensure that the artificial reef project accomplishes the goals that were intended. Socioeconomic impact evaluation is an important element; however it would be a fateful mistake not to consider non-use values such as posterity – the future does not belong to us alone.

The following matrix of best practices is composed from the discourse above and is modeled after the Goeller Scorecard; interviews with key stakeholders, existing literature, and the experience of previous artificial reef projects. The matrix represents the artificial reef proposal's required elements (X axis) and the decision making process (Y axis). Braided together these standards provide a chain of best practices that is the matrix below.

Table 5 Best Practice Matrix

BEST PRACTICE MATRIX

	Goals/Objectives	Design	Assessment/ Impacts	Measurement
Permits	5	5	5	5
TDC	5	5	5	5
DAC	5	5	5	5
FKNMS	5	5	5	5
Staff	5	5	5	5
Testimony	5	5	5	5
Public Input	5	5	5	5
Average Score*	**5**			
Maximum Score	**140**			
Approval Threshold	**71**			

To use the matrix the decision maker (e.g. BOCC) provides a score from zero to five, with zero representing the least amount of compliance to best practices and five representing the highest compliance. The proposal must meet the required elements of the X axis and the level of compliance is given a score. For example, if a proposal is given a "high" score on a low, medium, high scoring method by the FKNMS, the decision maker would place a 4 or 5 in the cell. This method is subjective to a degree, but politics and the political process is inherently subjective. This subjectivity allows the decision maker room for disagreement of a portion of the proposal but overall agreement of the project. The aggregated score by all decision makers is then compared to the maximum possible score and approval is based on exceeding the mean of the maximum score. The potential for manipulation is present; however with several inputs the possibility of determining the outcome is minimized. The majority vote will carry and

the decision is made individually. Therefore, the decision is recorded through a process that can be validated based on the individual decision maker's evaluation of the proposal.

A simple Excel spreadsheet or a similar application can be used to facilitate the tabulation and scoring. This matrix can be applied to each level of the decision making process where a board or other group is providing a recommendation for approval. A chart can easily be produced to give a visual representation such as in the example below.

Figure 16 Graph of Best Practice Matrix

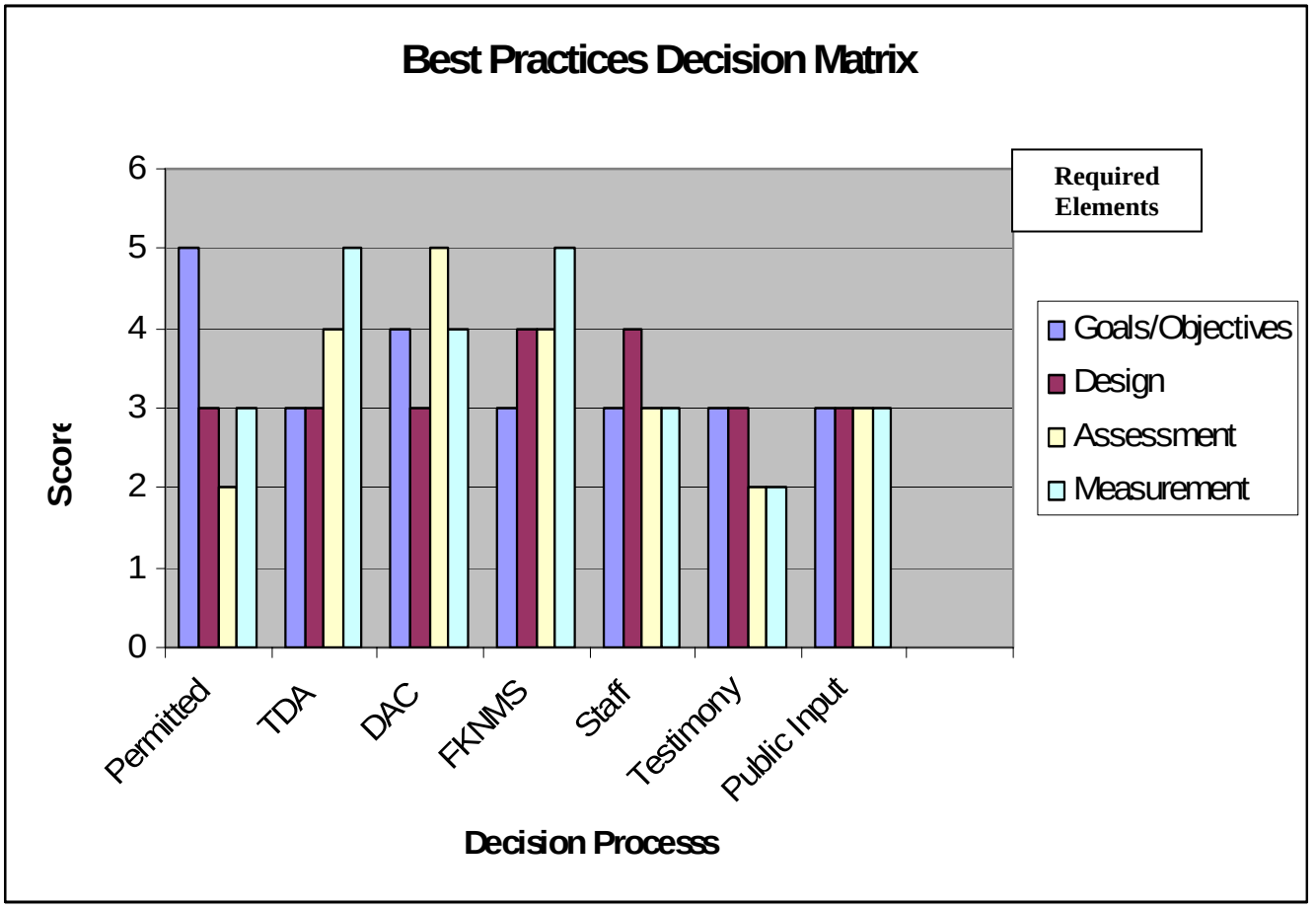

Table 6 Best Practice Scoring Matrix

	Goals/Objectives	Design	Assessment	Measurement
Permits	5	3	2	3
TDC	3	3	4	5
DAC	4	3	5	4
FKNMS	3	4	4	5
Staff	3	4	3	3
Testimony	3	3	2	2
Public Input	3	3	3	3
Score	**95**			
Decision	**Approved**			

Each item of the best practices matrix is explained below. This matrix can be modified to fit situational decision making once the process and required elements are defined.

Required Elements

Goals and Objectives: It is clear from the interviews with the key decision makers that clear goals and objectives are paramount in the evaluation of an artificial reef, or any development project. Unintended consequences such as aggregation of target fish for commercial/recreational fishing can invalidate an otherwise successful project, as was the case with earlier artificial reef projects. In order to evaluate post-deployment if the project is a success, that is, that the artificial reef is accomplishing what it is intended to, the goal and objectives must be clearly identified. For example, the primary goal may be to relieve use pressure on nearby natural reefs. The objective may be to increase numbers

of reef fish on the natural reef. Both can be measured by various means and can provide the decision maker feedback as to the need for modifying the artificial reef site/use.

Design: Design refers to the physical nature of the project; the ship to be used, its deployment, the site considerations such as current and bottom type, use such as SCUBA diving and penetration safety requirements, and location to evaluate travel from shore to site, etc. Design requires a great deal of technical data that is critical in the permitting process and is evaluated by those agencies that provide the necessary permits such as the ACOE and DEP.

Assessment: Assessment of the artificial reef project is discussed in terms of impacts. In Chapter 6 assessment/impact concepts and methods are discussed in more detail. Socioeconomic assessment is made through five realms of impacts which play an important role in the policy process. Each of the decision makers in the matrix will assess impacts of the artificial reef project. Several evaluation methods will be discussed and alternatives provided.

Measurement: This critical step includes two types of measurement: Pre and Post deployment. In order to determine the changes in the ecological and socioeconomic environments, existing conditions must be identified so that comparisons can be made to determine the level of impact the artificial reef project is having.

Decision Making Process

Permits: Permitting is the regulatory aspect of an artificial reef project. Permits are given by the ACOE, DEP, and governing agency (e.g. Monroe County). Permitting is a highly technical input that evaluates the design of the project as described above.

TDC: The Tourist Development Counsel is a very important *ad hoc* group in the Florida Keys and is given a large budget to promote the tourism industry. If a project is not successful it can have a significant negative affect on the economy of the Florida Keys. Conversely, if the project is a success as it appears the *Spiegel Grove* will be, it can provide a significant benefit to the region.

DAC: The Development Advisory Committee is an underused *ad hoc* group that has regional responsibilities and answers directly to the BOCC. The five regions of the DAC can provide valuable input at a community level that is politically important to the decision maker as well as understanding the impacts that an artificial reef project may have.

FKNMS: The waters surrounding the Florida Keys are within the jurisdiction of the FKNMS and an artificial reef project will require approval to be deployed with its boundaries. The FKNMS also has the resources of NOAA and others in the scientific community as well as the political considerations of a federal agency. As stated in the interview synopsis, the FKNMS is primarily concerned with the ecological and biological welfare of the sanctuary habitat. This welfare is intimately connected with the economic welfare of the region and the socioeconomic value the community places on it.

Staff: Governmental staff such as Monroe County are primarily concerned with the regulatory requirements and recognizes that the decisions are made at a political level. Staff acknowledges that they provide this data in the form of reports and testimony but have little input to the political process outside of compliance with governing doctrines.

Testimony: Expert testimony in the form of scientific and economic contributions at public hearings is an element that has been missing in previous projects. Members of the decision making bodies are rarely qualified to evaluate the comprehensive data that is required in the development of an artificial project. Written communication, reports, and studies are used if time is permitted; however, it was stated several times in the interviews that testimony at the public hearings would be very valuable in the decision making process.

Public Input: Public input is invaluable to policy makers as most speakers represent constituents and political survival. Stakeholders including businesses, environmental groups, and community organizations are tightly entwined with the political process. Decision makers are cognizant of their role in the political process that goes beyond any single project.

Using this decision making matrix, previous artificial reef projects can be evaluated using disaggregated method of matrix display. Aggregate methods are useful as initial screening devices and in helping individuals or small groups with similar preferences to select among options. The disaggregated approach may be more useful for public-sector problems where different groups hold different values and where political factors may loom large (Patton & Sawicki, 1993).

A commonly used disaggregate method is the *Goeller scorecard*; it results in a column of effects for each alternative, with each effect being expressed in its 'natural' units (Sexton et. al, 1999). In comparing the alternatives, the decision maker can assign whatever weight he/she deems appropriate to each effect. Explicit consideration of

weighting thus becomes a central item to the decision process itself, as it should be. A disadvantage of this approach is that the amount of detail makes it difficult for the decision maker to identify patterns or to come to conclusions without an understanding of the method (*Ibid*).

Chapter 8
CONCLUSION

The discussion has explored decision-making in Monroe County, Florida through the two recent artificial reef projects. Chapter 8 will complete the study and will draw conclusions from the previous discourse, discuss current decision-making activity, provide recommendations for improving the decision-making process, the need for future research, the limits of this study, and conclude with a summary of the study.

Supposition

What conclusions can be drawn from the above discourse? We know that there are little empirical data on artificial reefs and most of what is available from the literature review addresses artificial reefs from a fisheries perspective. We also know that the Florida Keys are a unique destination with a myriad of environmental and socioeconomic needs that have attracted concerns from a wide spectrum of stakeholders. Consequently, the ability to evaluate and/or forecast impacts of artificial reefs is difficult for decision-makers. Juxtaposition with the political pressures, it is no surprise that little has been done to explore the use of artificial reefs to relieve the pressures on the FKNMS. These difficulties are not limited to artificial reefs, but are also experienced throughout the decision-making process in areas where little empirical data are available and the political seas are in constant ebb and flow. The evidence presented in the earlier discussions draws conclusions that indicate that existing decision-making processes are inadequate and the need for establishing a system of best practices and project evaluation are needed. This study has provided a template flexible enough for variable input and

structured enough for consistency to assist decision-makers for establishing a process that encompasses best practices and is not arbitrary or capricious. As experience is gained and best practices are better defined, the model provided in this study can be modified to accommodate change in criteria variables and community need. The initial direction given by this study will provide an impetus for instituting a decision-making process that includes two critical elements – best practices and consistent evaluation.

Current Decision-Making Activity

Monroe County has initiated several decision-making processes in attempts to address the critical concerns of the Florida Keys environmental and socioeconomic sustainability. Recently Florida's Governor required Monroe County to complete their sensitive lands designations (AKA the Tier System) prior to receiving any further development allocations. Monroe County had been working feverously to complete the designations, only to have them appealed by two environmental groups. This delay throws a blanket of doubt onto the successful development of future environmental decisions such as artificial reef projects. The *Vandenberg* project continues with two major obstacles yet to overcome. As a result of the 2005 hurricane season which endured Katrina, Rita, and Wilma, the ACOE and FKNMS have required additional siting and engineering to ensure that the structure will not move as the result of a storm event –The *Spiegel Grove* did have movement as a result of hurricane *Rita*; the storm righted the vessel upright and it shifted ten feet seaward. Although somewhat ironic that it corrected the deployment malfunctions, the concerns that such a structure could move onto the reefs prompted the FKNMS to require additional anchoring requirements. The

Vandenberg's response to concerns of movement was to increase the weighting ballast and tie-downs and awaits approval of the new engineering plans. The final obstacle will be completing the financing of the project and complete the partnering strategies that will be integral in the debt recovery. The project's approval delay has resulted in a 1.4 million dollar deficit in the budget du to rising costs. The delays in Monroe County's environmental lands designation (the Tier System) jeopardizes possible funding assistance as funds cannot be dedicated until resolution of existing issues has been accomplished.

Therefore, we can conclude from current decision-making activity that existing decision-making processes are not adequate and revolve around spontaneous attempts to comply with approval criteria that are spurious or incomplete, without documented or empirical data to rely on. Most likely this activity is a result of the novelty of the requests and community needs, leaving the decision-makers without experience or information to apply to the evaluation.

The Future of Artificial Reefs in the Florida Keys

The FKMNS is extremely sensitive of the fragile existence of the Florida Keys' reef system. In the interview, the Superintendent stated that the possibility of additional artificial reefs exists, to be determined by need and post-deployment evaluation of the other projects and ongoing research of artificial reefs. The only proposal under consideration at the current time is the *Vandenberg*; however the conceptual discussions for an artificial reef in the Middle Florida Keys off of Marathon near the Sombraro Reef has received tentative and cautious encouragement. Resistance to additional artificial

reef projects primarily come from NOAA at the national level because of the minimal empirical data on artificial reef impacts. Once post-deployment data are collected and an analysis can be completed, the future for artificial reefs will become better defined. As the existing reef system continues to be "loved to death" alternatives to the existing use patterns must be created. Artificial reefs provide a realistic substitute and continue to gain public support and political momentum as demonstrated by the demand for derelict vessels such as the *Vandenberg* and most recently the *USS Orinsky* to be deployed off of Pensacola, Florida.

Need for Improvement

A study by J.D. Murray (1994) was published in the Bulletin of Marine Science that surveyed 12 artificial reef managers to examine their program's management relation to best practices. The results of the survey were the realization that no single approach addressed all the management aspects required in the decision-making processes. Many aspects were justified to have individual attention placed on them including socioeconomic, conflict analysis, and siting and design. These areas require comprehensive data collection and analysis above the level of expertise of most decision-making bodies. What the study does provide however, is that among existing artificial reef programs there is an inconsistency in the evaluation of project proposals. Implementing a best practices system with a structured evaluation method will provide consistency and direction to the decision-making process – a system that is desired by Monroe County decision-makers as indicated in the interviews. Measurement is critical for the ability to provide empirical data on the impacts of artificial reefs. Post-

deployment data collected from the *Spiegel Grove* will provide feedback to better evaluate artificial reef requests. Other artificial reef project data will enrich the existing literature, making decision-making more accurate and successful.

Decision-makers should adopt a process that utilizes established best practices and incorporates them into a decision-making matrix to provide consistency and accuracy. The model provided in this study incorporates recommendations by decision-makers and stakeholders collected throughout this study. Transferability of this process to decision-making other than artificial reefs can be accomplished by modifying the variables (e.g. design, impact parameters, etc.) and maintaining the principal concepts of best practices and standardized evaluation.

Need for Further Research

Further research is paramount for future artificial reef projects and the need to collect baseline data for comparison to evaluate the impacts that artificial reefs are having is necessary for decision-makers to evaluate the projects potential benefits and impacts. The research should be categorized or focused on the different types of structures such as abandoned oil rigs like those in Alabama and Texas, obsolete materials like the railroad cars used in Virginia, or derelict vessels from MARAD and the US Navy. Emphasis on this research should include the different uses these structures can provide and their use value, both market and non-market. Existing sites such as the *Yukon* in San Diego, CA and the *Duane* and *Bibb* in Key Largo, Florida are excellent candidates for evaluation as they are popular and frequently used sites with recent histories to provide pre and post deployment evaluation and comparisons. The

Hazen & Sawyer Report and subsequent NOAA Study are excellent first steps, but this information is outdated and needs to be revisited using a richer scope of evaluation criteria. Without empirical data the value of artificial reefs as alternatives for reef protection will not be credible and decision-makers will continue to struggle with impact forecasting, resulting in erroneous decisions with unintended consequences.

Study Limitations

The limits of this study are identified by the existing decision-making processes and accentuated by the lack reliable data in the literature. The limits of this study can therefore be categorized in two sections: 1) lack of research in the artificial reef proposal evaluation process; and 2) the lack of empirical pre and post artificial reef deployment data.

This study has identified a lack of comprehensiveness in regards to artificial reef decision-making by Monroe County and the limited scholarly information to draw evaluation criteria from. The decision-making process therefore, is largely accomplished with anecdotal evidence and the political persuasion of sophisticated stakeholders. Sitting through a public hearing or reading about your local government's decisions can make you question your representative's competence. Local government decision-making is often considered an enigma, without logic or reason. Much of the decision-making can take place behind the public's observation and influenced by the politics of their positions. These bewilderments are significant limitations to this study; many of these obstacles were experienced while researching the different aspects of this study. A lack of understanding the dynamics of the Florida Keys reef system and the continuing

deterioration of the FKNMS requires the decision-maker to enhance their ability to evaluate an artificial reef project proposal. Without the establishment of best practices for decision-making there will continue to be the lack of continuity in the decision-making process, requiring the realization that litigation is problematic and can result in an unpalatable ramification of the decision.

Second, and probably the most important as it links to a decision-makers ability to evaluate, is the lack of scientific analysis of the pre and post deployment of artificial reefs. The *Spiegel Grove* and the *Yukon* have initiated evaluation studies and are still several months away from drawing any conclusions. However, initial reports from the *Spiegel Grove* have indicated that the artificial reef is improving the health of nearby natural reefs while establishing its own stocks of reef fish. The empirical data will give the decision-makers their first source of reliable information from which to evaluate artificial reef project proposals. Further similar studies are needed on future artificial reef projects such as the *Vandenberg* and the *Orinsky*. In addition, post deployment studies on established artificial reefs such as the *Duane* and *Bibb* would be helpful to provide comparisons after the establishment of the structure.

Summary

Chapter 1 provided an introduction to artificial reefs and their origins and history of use. Chapter 2 discussed the problems and evaluation methods that decision-makers face when contemplating an artificial reef project in the Florida Keys. The Chapter also included the Problem Statement and Hypothesis for this dissertation. Chapter 3 reviewed the existing literature relevant to the study and discussed the interviews with key

decision-makers in the Florida Keys. Chapter 4 provided a snapshot into "paradise" known as the Florida Keys and the Florida Keys National Marine Sanctuary. Chapter 5 discussed the impacts artificial reefs can have through Economic and Environmental Impact Realms. Chapter 6 reviewed the artificial reef decision making process and included a brief discussion of the State of Florida's oversight administered by the Area of State Critical Concern designation. Chapter 7 introduces the decision-making matrix model utilizing the best practices developed from the study. Chapter 8 provides a conclusion to the study including a discussion for a need to further research the subject, limitations to the study, and a summary of the discourse.

There is no question of Monroe County's dependency on the reef-system, and the precarious position they have placed themselves in when considering future development. Because of the damaging "use" and anthropogenic impacts attention must be given to the critical state of the reef system with state and federal overview, limiting the authority and control locally. What does the future hold for the Florida Keys if action is not taken to protect the reef-system? What are the options for sustainability? Limiting use is not an option as the dependency for economic health is so closely tied to the use of the reef-system. Substitutes are the only logical alternative and artificial reefs are the only logical substitute.

What is the response to the Problem Statement and Hypothesis of this dissertation? The Problem Statement – **"Does the process used by local government decision-makers when considering an artificial reef project utilize best practices?"** The research indicates support of the Hypothesis that **"Local governments do not utilize**

best practices in decision-making when considering an artificial reef project.” This is demonstrated by Monroe County’s HCP and use of the NOAA Study, a study that emphasizes Travel Cost and Willingness-To-Pay valuation, as a primary evaluation method for the previous artificial reef projects. The limitations of the existing methods illustrate the need for better survey techniques and comprehensive analysis to determine the importance of non-use value to the visitors and residents of the Florida Keys. Making decisions without this important information is not developing sustainable policy. Without immediate intervention by decision-makers on use, the fears of the carrying capacity studies discussed within will come to fruition. Providing decision-makers with a richer scope of data and a method to obtain that data are paramount to the long-term sustainability and health of both the reef-system and the economy of Monroe County; this dissertation has provided the impetus for that development.

We have sailed endless sea in search of trade winds to fill the sails and steer our course straight to the “use value” islands. We have detoured slightly to avoid the doldrums and experienced a flavorful bounty of thought and question. This treasure-chest of experience for the nautical wheeler, the decision-maker, includes a compass to ensure fair winds and following seas and avoid the dangerous rocks - becoming an artificial reef.

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